Particle Data Group

Michael Barnett

November 8, 2005

Next edition

50th Anniversary

of the Particle Data Group

PDG particle data group

50th Anniversary

BERKELEY LAB

Under consideration

- Special festivities
- Special publication
- Special content in book and booklet
- Special covers
- Etc.

1957-2006

PDG

particle data group

M. Barnett - November 2005

50^{th} Anniversary

Coincides with:

- **Art Rosenfeld's 80^{th} birthday**
- **LBNL's 75^{th} anniversary (in August)**

Top Cited

According to SLAC Library, the Review is the all-time top cited article in High Energy Physics with 21,500 citations.

2nd is Weinberg's Standard Model paper with 5424

LBNL Leads

LBNL leads the

Particle Data Group collaboration

of 156 authors

from 17 countries and 90 institutions

+ 700 consultants in the HEP community

PDG Staff in Berkeley

<u>Staff for *Review of Particle Physics*</u>

Physicists:
- 4 half-time (2 FTE)
- 4 retired part-time

Editor/physicist

Administrative Assistant

This is marginally adequate to produce RPP and manage the collaboration.

2004 Review of Particle Physics

500 new papers with 1700 measurements
119 Reviews many written by external experts

RPP: 1100 pages

Booklet: 330 pages

Quality Assurance

- All reviews have 3-5 referees.
- Every item of data that is entered is checked by the experiments (700 people help).
- PDG Advisory Committee reviews all PDG operations

We strive to only report what is a fair consensus of the community.

We invite comments from the collaborations on many sections.

We organize mini-workshops when we need to consider expanded and improved coverage of a section.

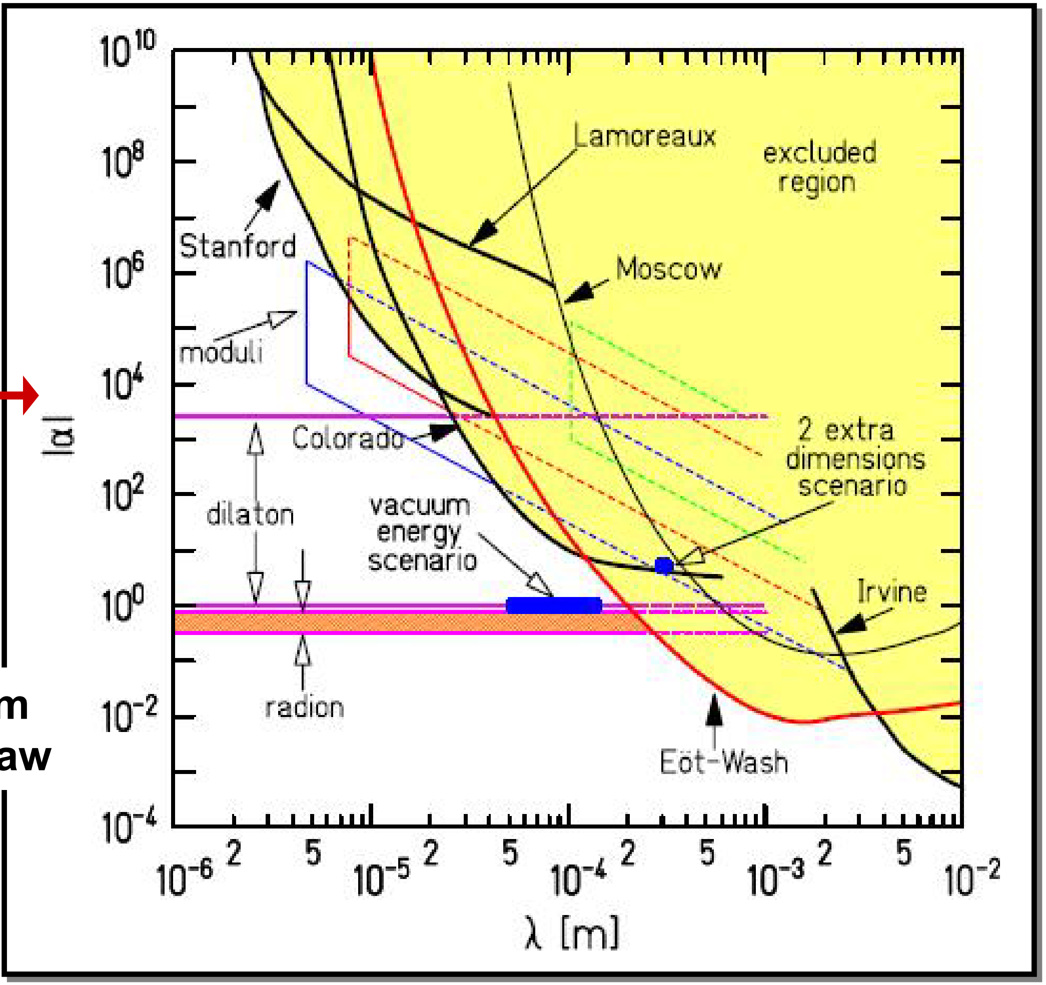
PDG Advisory Committee

Hiroaki Aihara	(Tokyo)
Persis Drell	(SLAC)
Rudiger Voss	(CERN)
Michael Whalley	(Durham)
Peter Zerwas	(DESY)

Vital PDG Workshops

Workshops lead to improved coverage

- Neutrino
- CKM
- D Meson
- τ lepton
- Extra-dimensions



Constraints on deviations from Newton's gravitational force law

Collaboration with Working Groups

Coordination with working groups at

LEP, Tevatron and B-factory on:

- Electroweak fits,
- B lifetimes, B mixing,
- V_{cb} and V_{ub}
- top quark mass, etc.

PDG role in:

- CKM workshops (CERN 2002, Durham 2003, San Diego 2005)
- Statistics workshops, etc.

Astrophysics & Cosmology

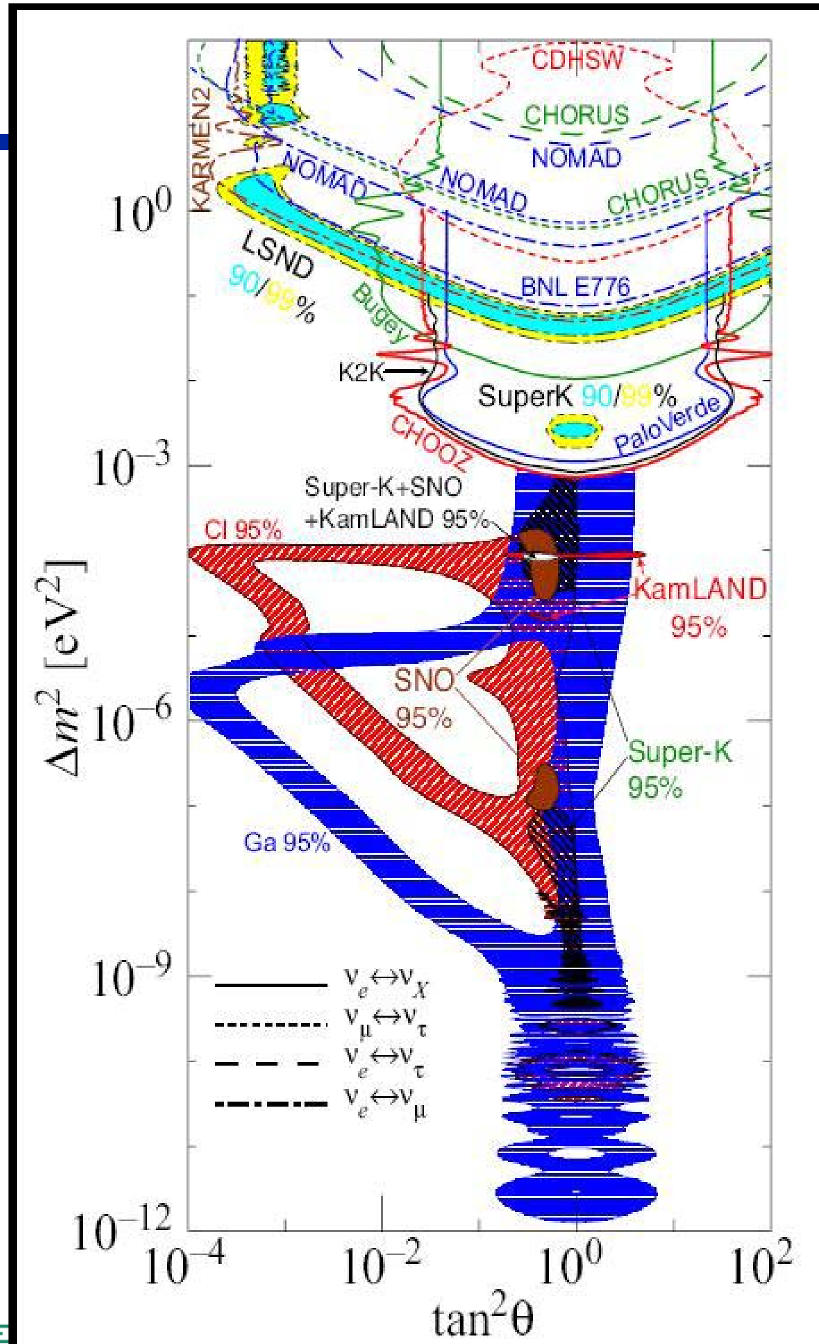
10 years ago: Very little

Now:

Astrophysical Constants
Big Bang Cosmology
Cosmological Parameters:
H_0, Λ, Ω, etc.
Experimental Tests of Gravitational Theory
Dark Matter
Cosmic Background Radiation
Cosmic Rays

ν Mixing

New plot (November 2005) shows large mixing of neutrinos



Hitoshi Murayama

Changes

Latest top mass world average is

$172.7 \pm 1.7 \pm 2.4$

in top quark review (major update)
from the TeV-EWWG.

RPP 2005 average was 178.0 ± 4.3.

New measurement of the neutron lifetime
is 6.5 σ from RPP 2004.

V_{ud} and V_{us}

New

The Cabibbo Angle and CKM Unitarity

E. Blucher [1] and W.J. Marciano [2]

[1] *The Enrico Fermi Institute, The University of Chicago, Chicago, Illinois 60637*

[2] *Brookhaven National Laboratory, Upton, New York 11973*

The Cabibbo-Kobayashi-Maskawa (CKM) [1, 2] 3-generation quark mixing matrix wr
ten in terms of the Wolfenstein parameters (λ, A, ρ, η) [3] nicely illustrates the orthonormali
constraint of unitarity and central role played by λ.

$$V_{CKM} = \begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix} = \begin{pmatrix} 1-\frac{\lambda^2}{2} & \lambda & A\lambda^3(\rho - i\eta) \\ -\lambda & 1-\frac{\lambda^2}{2} & A\lambda^2 \\ A\lambda^3(1-\rho-i\eta) & -A\lambda^2 & 1 \end{pmatrix} + \mathcal{O}(\lambda^4) \quad ($$

That cornerstone is a carryover from the two-generation Cabibbo angle, $\lambda = sin\theta_{Cabibbo}$
V_{us}. Its value is a critical ingredient in determinations of the other parameters and in tes
of CKM unitarity.

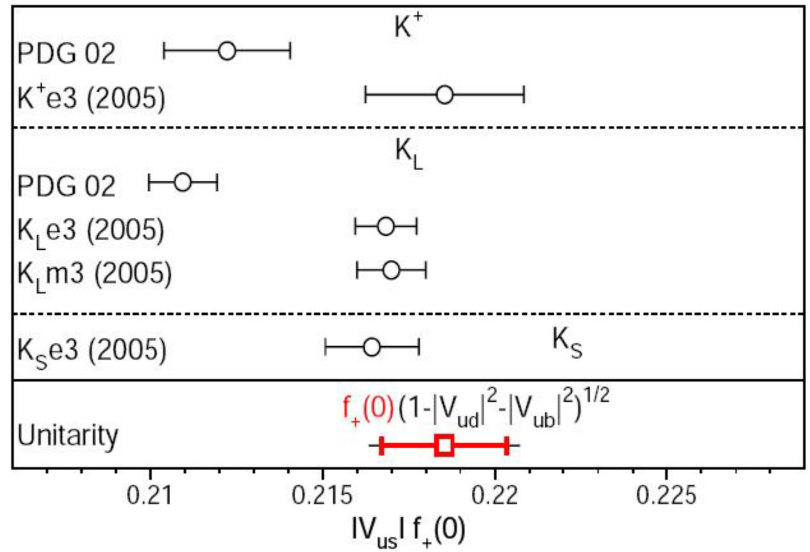
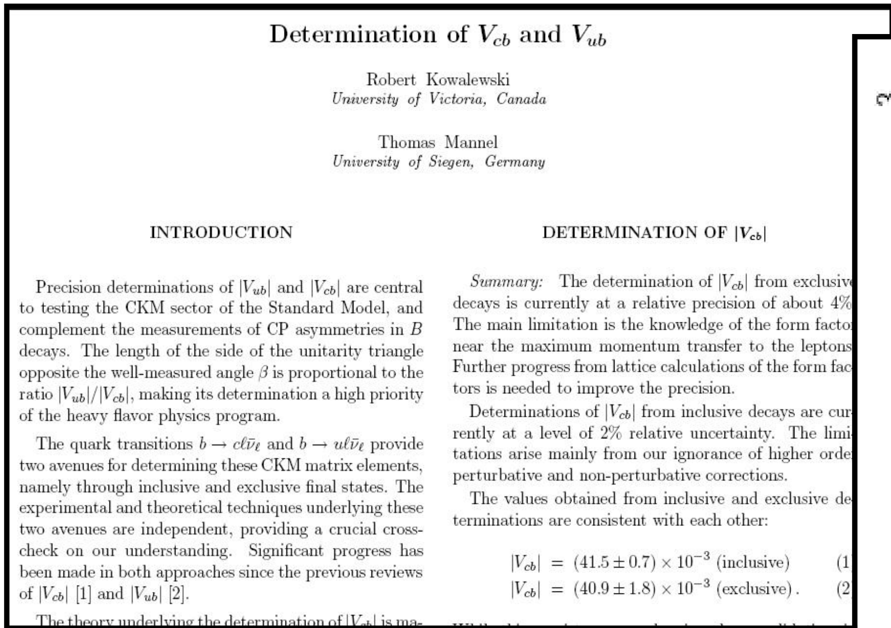


FIG. 2: Comparison of determinations of $|V_{us}|f_+(0)$ from this review (labelled 2005), from the PDG 2002, and with the prediction from unitarity using $|V_{ud}|$ and the Leutwyler-Roos calculation of $f_+(0)$ [26]. For $f_+(0)(1-|V_{ud}|^2-|V_{ub}|^2)^{1/2}$, the inner error bars are from the quoted uncertainty in $f_+(0)$; the total uncertainties include the $|V_{ud}|$ and $|V_{ub}|$ errors.

V_{ub} and V_{cb}



Determination of V_{cb} and V_{ub}

Robert Kowalewski
University of Victoria, Canada

Thomas Mannel
University of Siegen, Germany

INTRODUCTION

Precision determinations of $|V_{ub}|$ and $|V_{cb}|$ are central to testing the CKM sector of the Standard Model, and complement the measurements of CP asymmetries in B decays. The length of the side of the unitarity triangle opposite the well-measured angle β is proportional to the ratio $|V_{ub}|/|V_{cb}|$, making its determination a high priority of the heavy flavor physics program.

The quark transitions $b \to c\ell\bar{\nu}_\ell$ and $b \to u\ell\bar{\nu}_\ell$ provide two avenues for determining these CKM matrix elements, namely through inclusive and exclusive final states. The experimental and theoretical techniques underlying these two avenues are independent, providing a crucial cross-check on our understanding. Significant progress has been made in both approaches since the previous reviews of $|V_{cb}|$ [1] and $|V_{ub}|$ [2].

The theory underlying the determination of $|V_{cb}|$ is ma-

DETERMINATION OF $|V_{cb}|$

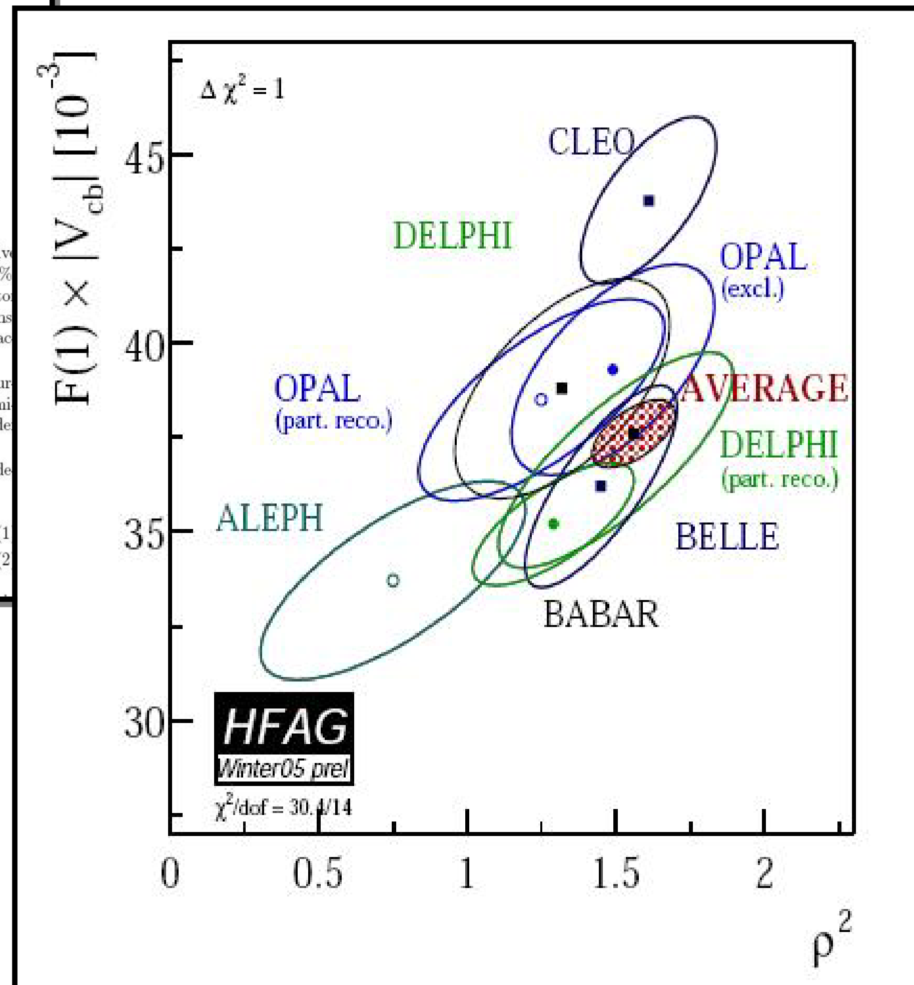
Summary: The determination of $|V_{cb}|$ from exclusive decays is currently at a relative precision of about 4% The main limitation is the knowledge of the form facto near the maximum momentum transfer to the leptons Further progress from lattice calculations of the form fac tors is needed to improve the precision.

Determinations of $|V_{cb}|$ from inclusive decays are cur rently at a level of 2% relative uncertainty. The limi tations arise mainly from our ignorance of higher orde perturbative and non-perturbative corrections.

The values obtained from inclusive and exclusive de terminations are consistent with each other:

$$|V_{cb}| = (41.5 \pm 0.7) \times 10^{-3} \text{ (inclusive)} \quad (1$$
$$|V_{cb}| = (40.9 \pm 1.8) \times 10^{-3} \text{ (exclusive)}. \quad (2$$

New



g-2

The Muon Anomalous Magnetic Moment

Andreas Höcker[1] and William J. Marciano[2]

[1] CERN, CH-1211 Geneva 23, Switzerland

[2] Brookhaven National Laboratory, Upton, NY 11973, USA

The Dirac equation predicts a muon magnetic moment, $\vec{M} = g_\mu \frac{e}{2m_\mu}\vec{S}$, with gyromagnetic ratio $g_\mu = 2$. Quantum loop effects lead to a small calculable deviation from $g_\mu = 2$, parameterized by the anomalous magnetic moment

$$a_\mu \equiv \frac{g_\mu - 2}{2} . \tag{1}$$

$$a_\mu^{\mathrm{SM}} = 116\,591\,858(72)(35)(3) \times 10^{-11} .$$

The difference between experiment and theory

$$\Delta a_\mu = a_\mu^{\mathrm{exp}} - a_\mu^{\mathrm{SM}} = 22(10) \times 10^{-10} ,$$

New

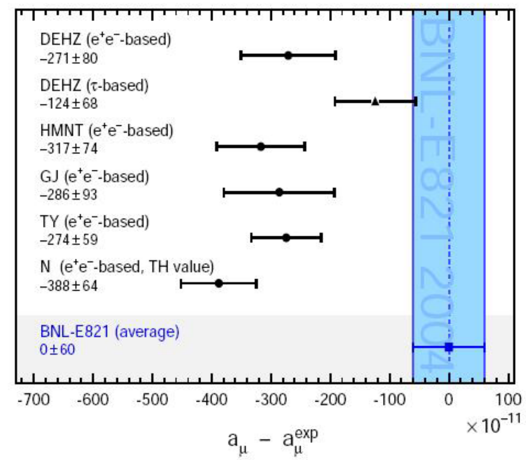
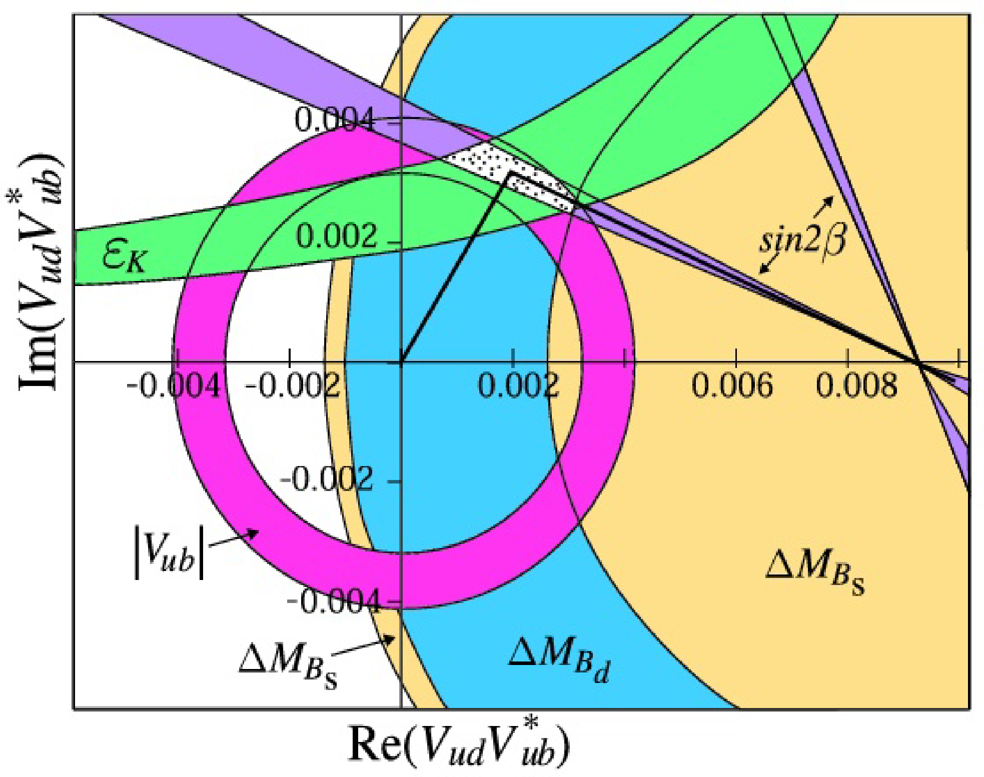
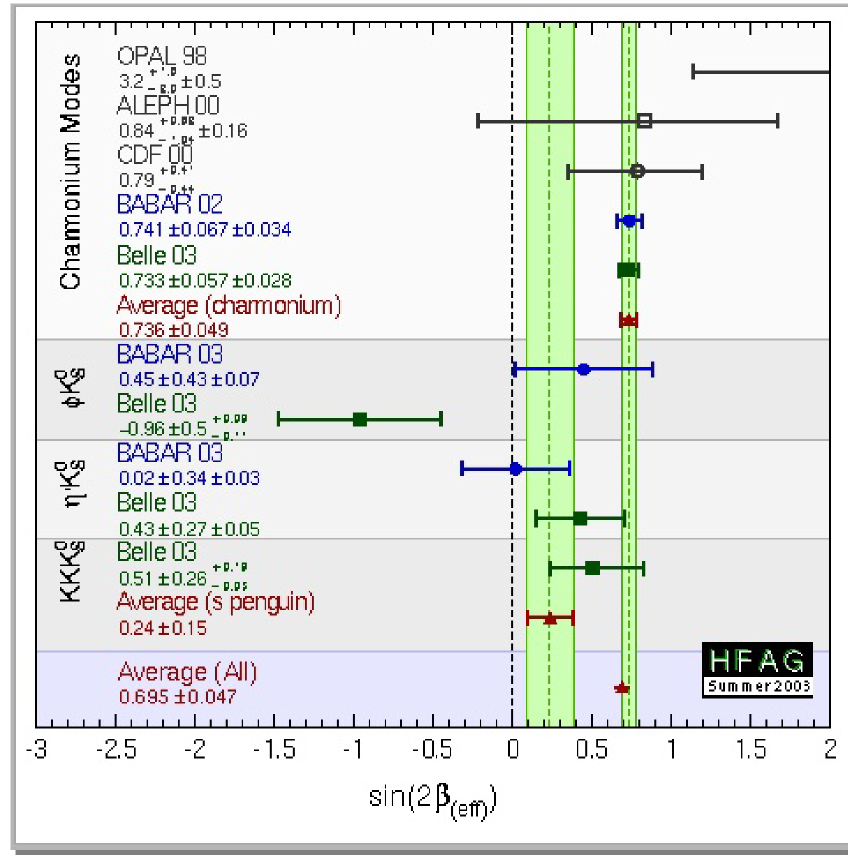


FIG. 2: Compilation of recently published results for a_μ (in units of 10^{-11}), subtracted by the central value of the experimental average (3). The shaded band indicates the experimental error. The SM predictions are taken from: DEHZ [13], HMNT [16], GJ [18], TY [19], N [20]. Note that the quoted errors do not include the uncertainty on the subtracted experimental value. To obtain for each theory calculation a result equivalent to Eq. (16), one has to add the errors from theory and experiment in quadrature.

CP Review

by Yossi Nir and David Kirkby
Unifies CP Violation in K, D and B Mesons





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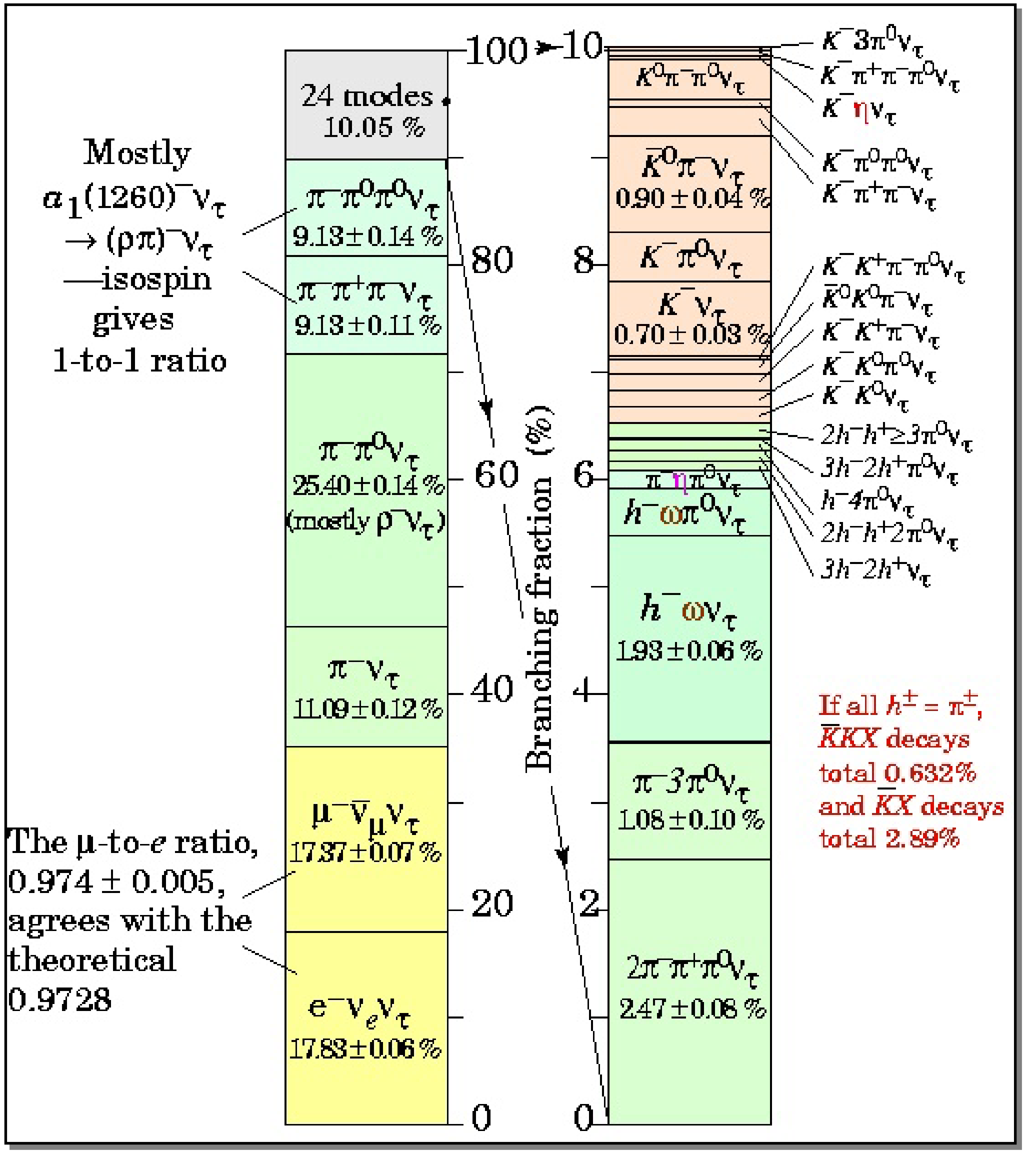
Complex Fits with Correlations

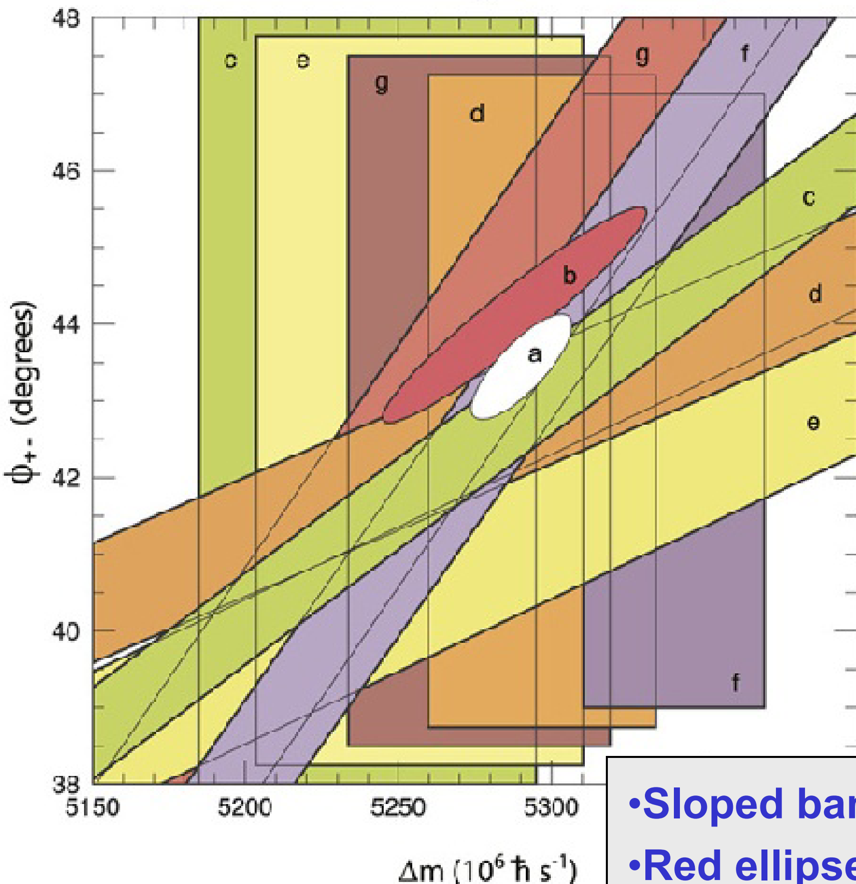
e.g. τ Branching Fractions



K_L CP Violation Fit

K_L CP Violation Fit

(χ^2=17.4 for 13 degrees of freedom)



Label	Source	Year
a	Combined fit	2004
b	FNAL KTeV	2003
c	CERN CPLEAR	1999
d	FNAL E773	1995
e	FNAL E731	1993
f	CERN	1974
g	CERN NA31	1990

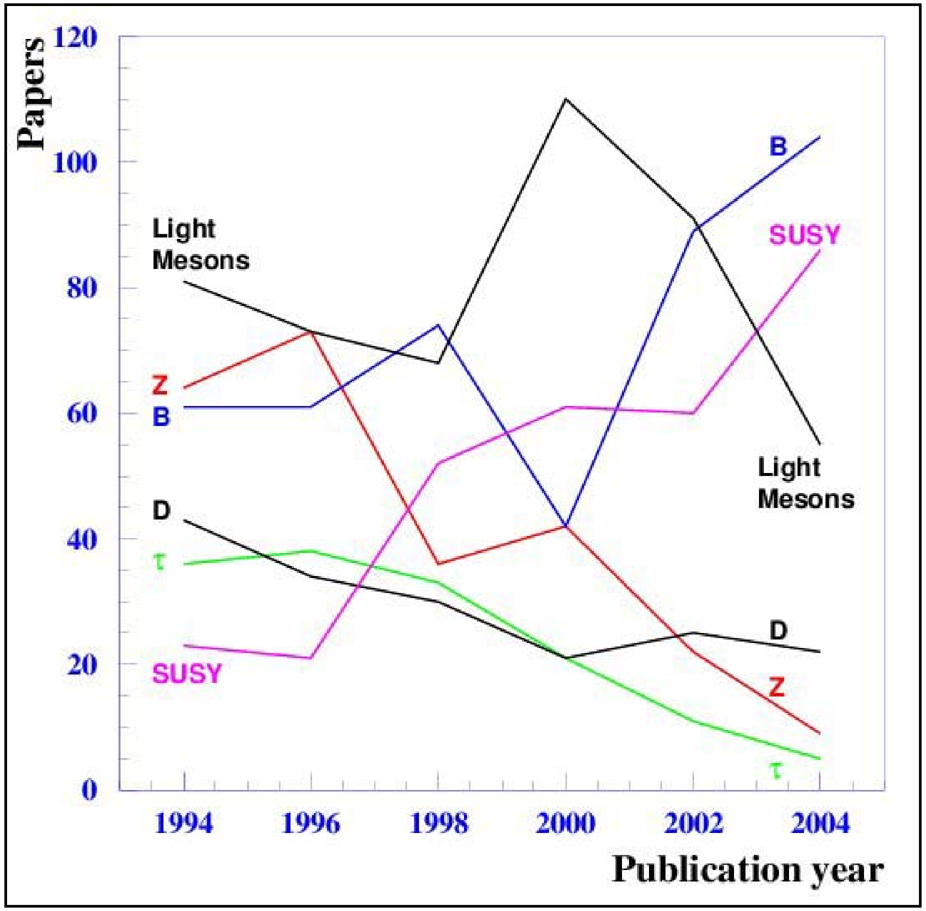
ϕ_{+-} is phase of η_{+-}

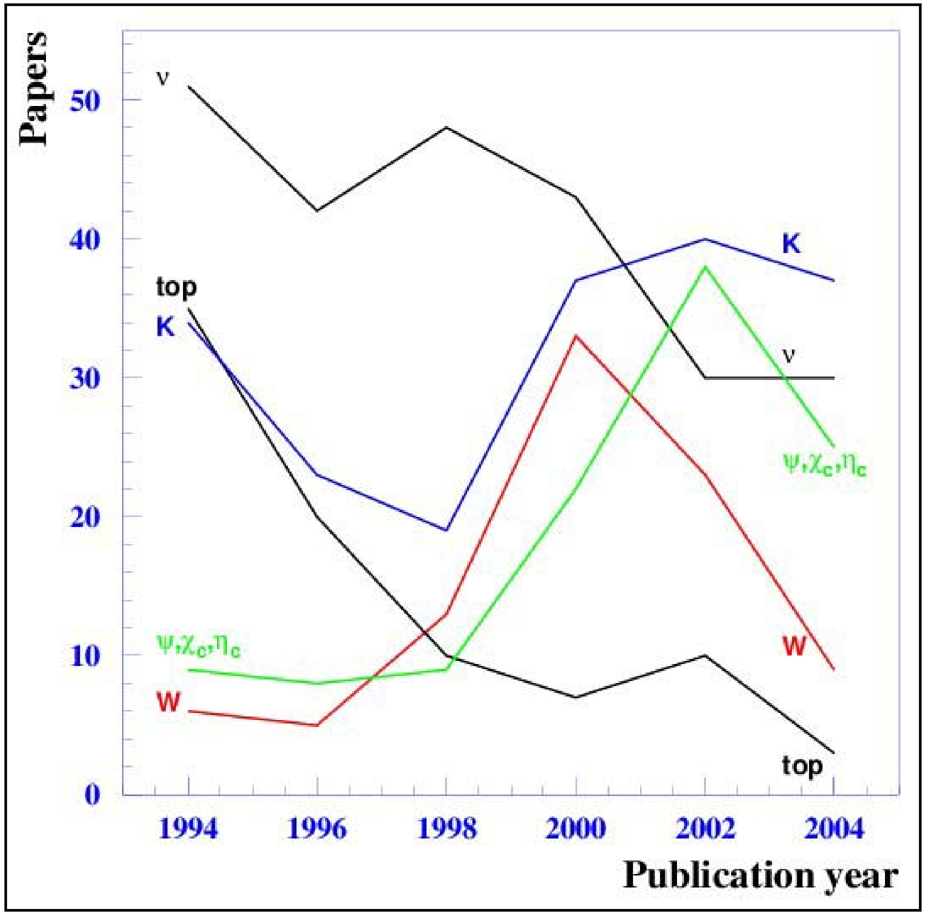
$$\eta_{+-} = \frac{\text{ampl}\,(K_L \to \pi^+\pi^-)}{\text{ampl}\,(K_S \to \pi^+\pi^-)}$$

Δm is $K_L - K_S$ mass diff.

- Sloped bands show dependence of ϕ meas.'s on Δ(m)
- Red ellipse is meas. with correlation between ϕ and Δ.
- Vertical bands are meas.'s of Δ independent of ϕ.

Trends in coverage





Notice different vertical scales

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Future of RPP on the Web

Finding the information you want will become much easier:

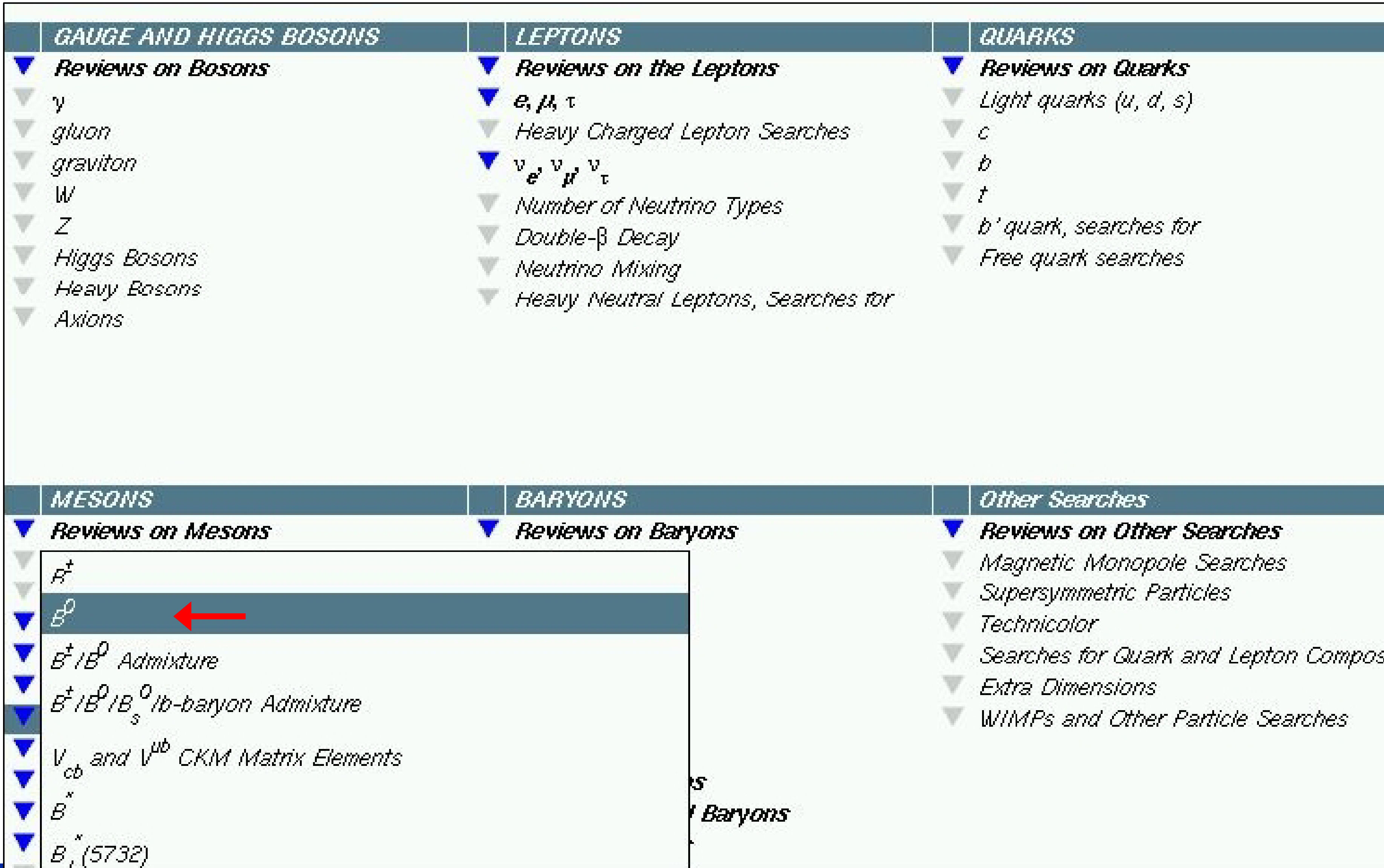
- Enable powerful searches of RPP database
- Produce search results with Greek and math
- Link References to actual papers

Starting Page

GAUGE AND HIGGS BOSONS	LEPTONS	QUARKS
Reviews on Bosons	Reviews on the Leptons	Reviews on Quarks
γ	e, μ, τ	Light quarks (u, d, s)
gluon	Heavy Charged Lepton Searches	c
graviton	ν_e, ν_μ, ν_τ	b
W	Number of Neutrino Types	t
Z	Double-β Decay	b′ quark, searches for
Higgs Bosons	Neutrino Mixing	Free quark searches
Heavy Bosons	Heavy Neutral Leptons, Searches for	
Axions		

MESONS	BARYONS	Other Searches
Reviews on Mesons	Reviews on Baryons	Reviews on Other Searches
Light Unflavoured Mesons	N Baryons	Magnetic Monopole Searches
Other Light Unflavoured Mesons	Δ Baryons	Supersymmetric Particles
Strange Mesons	Exotic Baryons	Technicolor
Charmed Mesons	Λ Baryons	Searches for Quark and Lepton Compositene
Charmed, Strange Mesons	Σ Baryons	Extra Dimensions
Bottom Mesons	Ξ Baryons	WIMPs and Other Particle Searches
Bottom, Strange Mesons	Ω Baryons	
Bottom, Charmed Mesons	Charmed Baryons	
$c\bar{c}$ Mesons	Doubly-Charmed Baryons	
$b\bar{b}$ Mesons	Bottom Baryons	
Non $q\bar{q}$ Candidates		

Select B^0



GAUGE AND HIGGS BOSONS
Reviews on Bosons
γ
gluon
graviton
W
Z
Higgs Bosons
Heavy Bosons
Axions
LEPTONS
Reviews on the Leptons
e, μ, τ
Heavy Charged Lepton Searches
νe, νμ, ντ
Number of Neutrino Types
Double-β Decay
Neutrino Mixing
Heavy Neutral Leptons, Searches for
QUARKS
Reviews on Quarks
Light quarks (u, d, s)
c
b
t
b′ quark, searches for
Free quark searches
MESONS
Reviews on Mesons
B±
B0
B±/B0 Admixture
B±/B0/Bs0/b-baryon Admixture
Vcb and Vub CKM Matrix Elements
B*
BJ*(5732)
BARYONS
Reviews on Baryons
Other Searches
Reviews on Other Searches
Magnetic Monopole Searches
Supersymmetric Particles
Technicolor
Extra Dimensions
WIMPs and Other Particle Searches

Select Decay Mode

B^0 DECAY MODES	Fraction (Γ_i/Γ)	Scale factor/ Confidence level
Inclusive modes		
D, D^*, or D_s modes		
Charmonium modes		
Γ_{98} $\eta_c K^0$	$(1.2 \pm 0.4) \times 10^{-3}$	
Γ_{99} $\eta_c K^*(892)^0$	$(1.6 \pm 0.7) \times 10^{-3}$	
Γ_{100} $J/\psi(1S) K^0$	$(8.5 \pm 0.5) \times 10^{-4}$	
Γ_{101} $J/\psi(1S) K^+ \pi^-$	$(1.2 \pm 0.6) \times 10^{-3}$	
Γ_{102} $J/\psi(1S) K^*(892)^0$	$(1.31 \pm 0.07) \times 10^{-3}$	
Γ_{103} $J/\psi(1S) \phi K^0$	$(9.4 \pm 2.6) \times 10^{-5}$	
Γ_{104} $J/\psi(1S) K(1270)^0$	$(1.3 \pm 0.5) \times 10^{-3}$	
Γ_{105} $J/\psi(1S) \pi^0$	$(2.2 \pm 0.4) \times 10^{-5}$	
Γ_{106} $J/\psi(1S) \eta$	$<2.7 \times 10^{-5}$	CL=90%
Γ_{107} $J/\psi(1S) \pi^+ \pi^-$	$(4.6 \pm 0.9) \times 10^{-5}$	
Γ_{108} $J/\psi(1S) \rho^0$	$(1.6 \pm 0.7) \times 10^{-5}$	
Γ_{109} $J/\psi(1S) \omega$	$<2.7 \times 10^{-4}$	CL=90%
Γ_{110} $J/\psi(1S) \phi$	$<9.2 \times 10^{-6}$	CL=90%
Γ_{111} $J/\psi(1S) \eta'(958)$	$<6.3 \times 10^{-5}$	CL=90%
Γ_{112} $J/\psi(1S) K^0 \pi^+ \pi^-$	$(1.0 \pm 0.4) \times 10^{-3}$	
Γ_{113} $J/\psi(1S) K^0 \rho^0$	$(5.4 \pm 3.0) \times 10^{-4}$	

See Data Listing

$\Gamma(J/\psi(1S)\,K^0)/\Gamma_{total}$ Section References Γ_{100}/Γ

back to B^0

For branching ratios in which the charge of the decaying B is not determined, see the $B^{\pm}$ section.

Γ_{100}/Γ

VALUE (10^{-4})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
8.5 ± 0.5			**OUR AVERAGE**			
7.9 ± 0.4 ± 0.9			1 ABE	03B	BELL	$e^+e^- \to \Upsilon(4S)$
8.3 ± 0.4 ± 0.5			1 AUBERT	02	BABR	$e^+e^- \to \Upsilon(4S)$
9.5 ± 0.8 ± 0.6			1 AVERY	00	CLE2	$e^+e^- \to \Upsilon(4S)$
11.5 ± 2.3 ± 1.7			2 ABE	96H	CDF	$p\bar{p}$ at 1.8 TeV
6.9815 ± 4.1949 ± 0.1177			3 BORTOLETTO	92	CLEO	$e^+e^- \to \Upsilon(4S)$
9.3086 ± 7.3586 ± 0.1570		2	4 ALBRECHT	90J	ARG	$e^+e^- \to \Upsilon(4S)$
* * * We do not use the following data for averages, fits, limits, *etc.* * * *						
$8.5^{+1.4}_{-1.2} \pm 0.6$			1 JESSOP	97	CLE2	Repl. by AVERY 2000
7.5 ± 2.4 ± 0.8		10	3 ALAM	94	CLE2	Sup. by JESSOP 1997
<50	90		ALAM	86	CLEO	$e^+e^- \to \Upsilon(4S)$

1 Assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$.

2 ABE 1996H assumes that B($B^+ \to J/\psi K^+$) = (1.02 ± 0.14) × 10^{-3}.

3 BORTOLETTO 1992 reports 6 ± 3 ± 2 for B($J/\psi(1S) \to e^+e^-$) = 0.069 ± 0.009. We rescale to our best value B($J/\psi(1S) \to e^+e^-$) = (5.93 ± 0.10) × 10^{-2}. Our first error is their experiment's error and our second error is the systematic error from using our best value. Assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$.

4 ALBRECHT 1990J reports 8 ± 6 ± 2 for B($J/\psi(1S) \to e^+e^-$) = 0.069 ± 0.009. We rescale to our best value B($J/\psi(1S) \to e^+e^-$) =

Link Directly to Spires

SPIRES

HEP :: HEPNAMES :: INSTITUTIONS :: CONFERENCES :: EXPERIMENTS :: JO

Modify your search below.

FIND KEY 4676572

Browse Author | Format: **Standard** Cites Citesummary LaTeX

MEASUREMENT OF BRANCHING FRACTIONS FOR EXCLUSIVE B DECAYS TO CHARMONIUM FINAL STATES
By BABAR Collaboration (B. Aubert *et al.*). SLAC-PUB-8909, BABAR-PUB-01-07, Jul 2001. 25pp.
Published in **Phys.Rev.D65:032001,2002**
e-Print Archive: **hep-ex/0107025**

- List of Authors TOPCITE = 50+
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- EXP SLAC-PEP2-BABAR

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FULL LIST OF MEASUREMENTS

AUBERT 2002
BaBar Collab.

Physical Review D65 (2002) 032001
Measurement of Branching Fractions for Exclusive *B* Decays to Charmonium Final States

	Measurement			(Unit)	Particle (Section)	Observable
used	10.1	± 0.3	± 0.5	(10^{-4})	$B^{\pm}$	$\Gamma(J/\psi(1S)K^{+})/\Gamma_{total}$
used	1.37	± 0.09	± 0.11	(10^{-3})	$B^{\pm}$	$\Gamma(J/\psi(1S)K^{*}(892)^{+})/\Gamma_{total}$
used	1.37	± 0.10	± 0.08		$B^{\pm}$	$\Gamma(J/\psi(1S)K^{*}(892)^{+})/\Gamma(J/\psi(1S)K^{-})$
used	6.4	± 0.5	± 0.8	(10^{-4})	$B^{\pm}$	$\Gamma(\psi(2S)K^{+})/\Gamma_{total}$
used	0.64	± 0.06	± 0.07		$B^{\pm}$	$\Gamma(\psi(2S)K^{+})/\Gamma(J/\psi(1S)K^{+})$
used	6.4794	± 1.0351	± 0.6766	(10^{-4})	$B^{\pm}$	$\Gamma(\chi_{c1}(1P)K^{+})/\Gamma_{total}$

Link Directly to Paper

PHYSICAL REVIEW D, VOLUME 65, 032001

Measurement of branching fractions for exclusive B decays to charmonium final states

B. Aubert, D. Boutigny, J.-M. Gaillard, A. Hicheur, Y. Karyotakis, J. P. Lees, P. Robbe, and V. Tisserand
Laboratoire de Physique des Particules, F-74941 Annecy-le-Vieux, France

A. Palano
Università di Bari, Dipartimento di Fisica and INFN, I-70126 Bari, Italy

G. P. Chen, J. C. Chen, N. D. Qi, G. Rong, P. Wang, and Y. S. Zhu
Institute of High Energy Physics, Beijing 100039, China

G. Eigen, P. L. Reinertsen, and B. Stugu
University of Bergen, Institute of Physics, N-5007 Bergen, Norway

B. Abbott, G. S. Abrams, A. W. Borgland, A. B. Breon, D. N. Brown, J. Button-Shafer, R. N. Cahn, A. R. Clark

We report branching fraction measurements for exclusive decays of charged and neutral B mesons into two-body final states containing a charmonium meson. We use a sample of 22.72 ± 0.36 million $B\bar{B}$ events collected between October 1999 and October 2000 with the *BABAR* detector at the PEP-II storage rings at the Stanford Linear Accelerator Center. The charmonium mesons considered here are J/ψ, $\psi(2S)$, and χ_{c1}, and the light meson in the decay is either a K, K^*, or π^0.

DOI: 10.1103/PhysRevD.65.032001 PACS number(s): 13.25.Hw, 11.30.Er

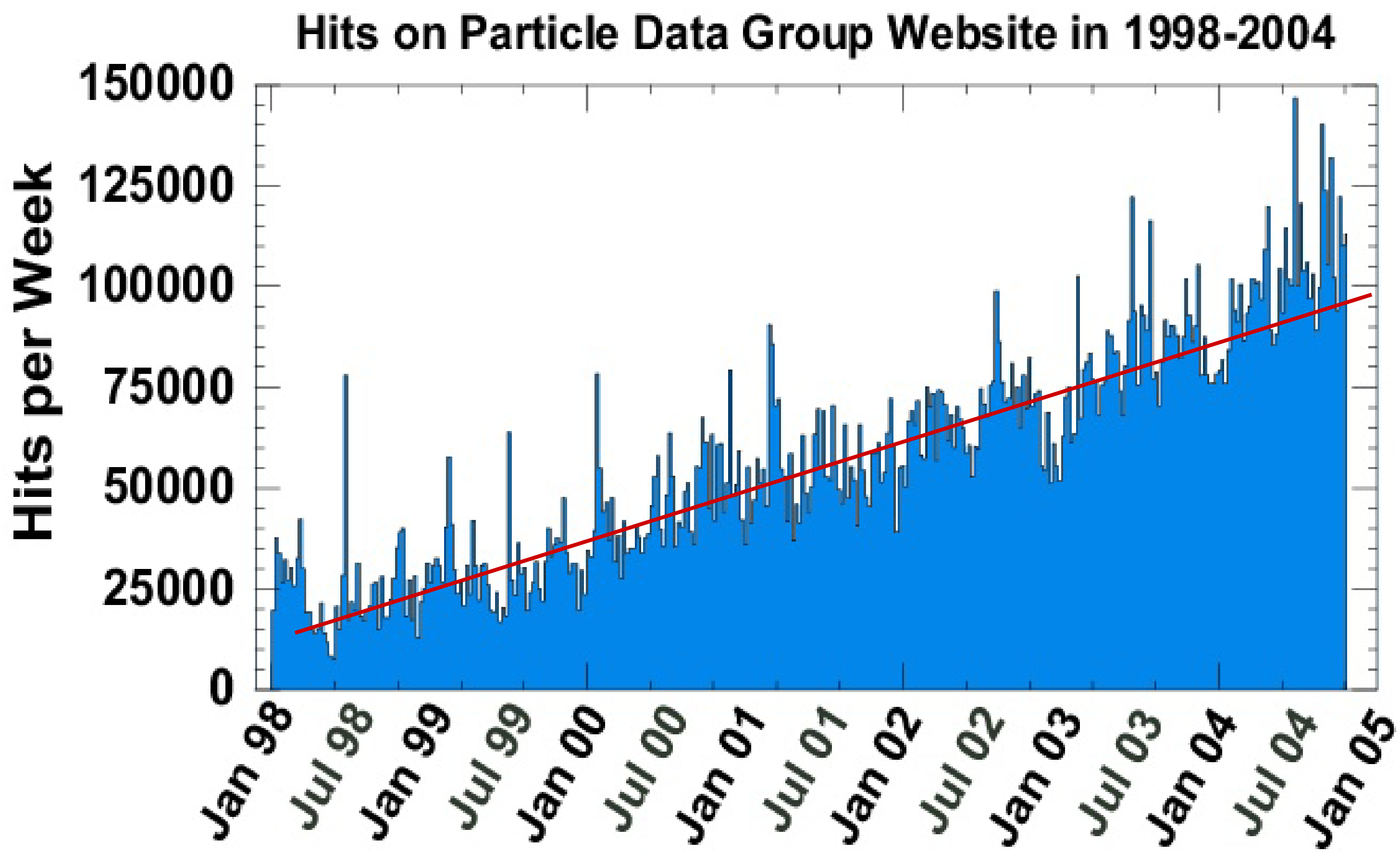
Consequences

PDG Dynamic Improvements $\longrightarrow$

- 29,500 Booklets requested
- 14,200 RPP books requested
- 5 million hits/year on website (>140 countries)
- 20,000 citations of RPP
- Most cited publication in HEP

More Consequences

Excluding mirror sites and excluding Education webpages



2005 Web Update

PDG produced the 2005 web update of the Listings and is preparing the 2006 book edition.

New reviews are underway.

Hoping to meet schedule.

The 2004 edition has already been cited 1750 times (the 1998, 2000, and 2002 editions were each cited 3000 times).

NSF Reviewers

"Reviewing the proposal for the PDG is somewhat akin to reviewing motherhood. The services that have been provided by this group to the world community of high energy physicists is of inestimable value. It is carried out with great competence, which accounts for its wide acceptance."

"The work of the PDG is absolutely necessary for rapid progress of elementary particle physics. Without it, the field would be very fragmented and achieving consensus would be very difficult."

"They have anticipated needs of HEP scientists extremely well. The data provided by the PDG is the best I know about in all fields. Everybody in HEP makes use of the review and many scientists outside HEP."

NSF Reviewers

"It would be hard to imagine HEP without it, and I do not know any other group capable of this effort. The group competence and past accomplishments are excellent."

"The Particle Data Books become "bibles" to researchers in particle physics. Without this work, progress would be slower."

... an extremely valuable resource to the particle physics community. This effort is invaluable and must be supported. This is constantly being improved and expanded.

PDG Advisory Committee

"With this edition [2004], the Particle Data Group has continued to provide the outstanding and essential service that the scientific community has become used to expect, and has once again confirmed and reinforced the unique role of the RPP as the central and authoritative source of reference data in particle physics."

"The next PDG collaboration meeting in autumn 2006 will mark the 50th anniversary of the Particle Data Group. The Committee recommends that the PDG uses this occasion to organize a symposium that should involve not only the collaboration, but also representatives of the Particle Physics Community at large."

PDG Summary

PDG provides a vital, dynamic, innovative service to the HEP community

The HEP community depends on PDG to provide standards and to assure integrity and quality in summarizing particle physics

Outreach

- PDG
- ATLAS
- QuarkNet
- Contemporary Physics Education Project
- European Outreach Group
- NOVA
- Nobel Foundation
- etc.

Covering

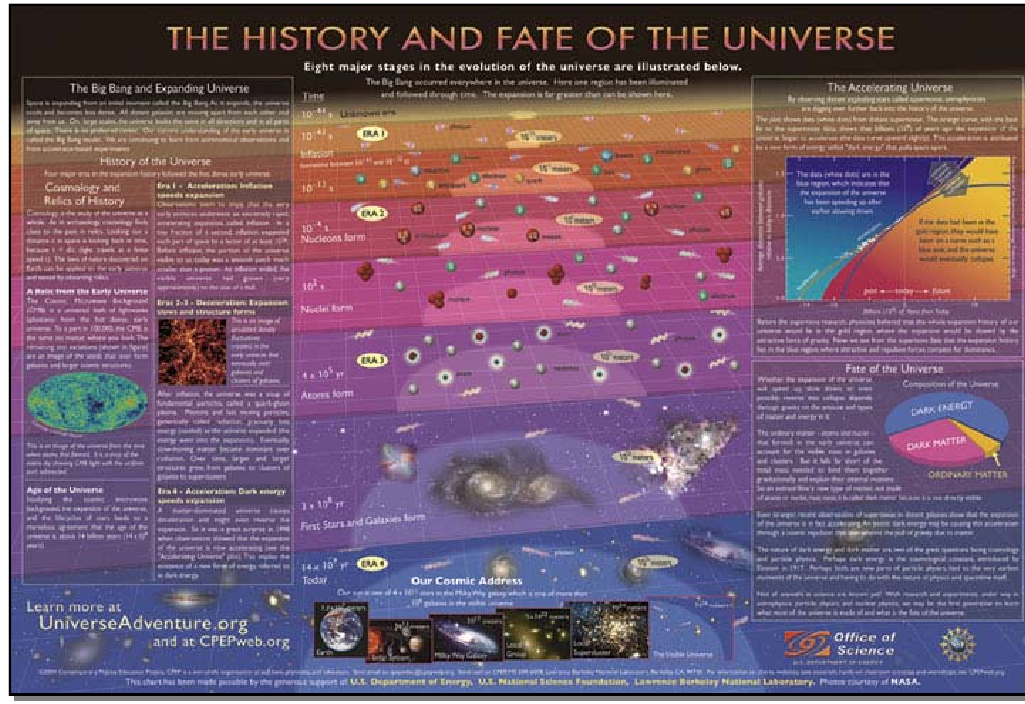
Cosmology and Particle Physics

Outreach Programs

- Programs/Research for High School Teachers and Students
- Websites for Public and Students
- Special Events and Webcasts
- Educational Materials
  - Books and booklets
  - Charts, Placemats, Transparencies
  - CDROMs, Films

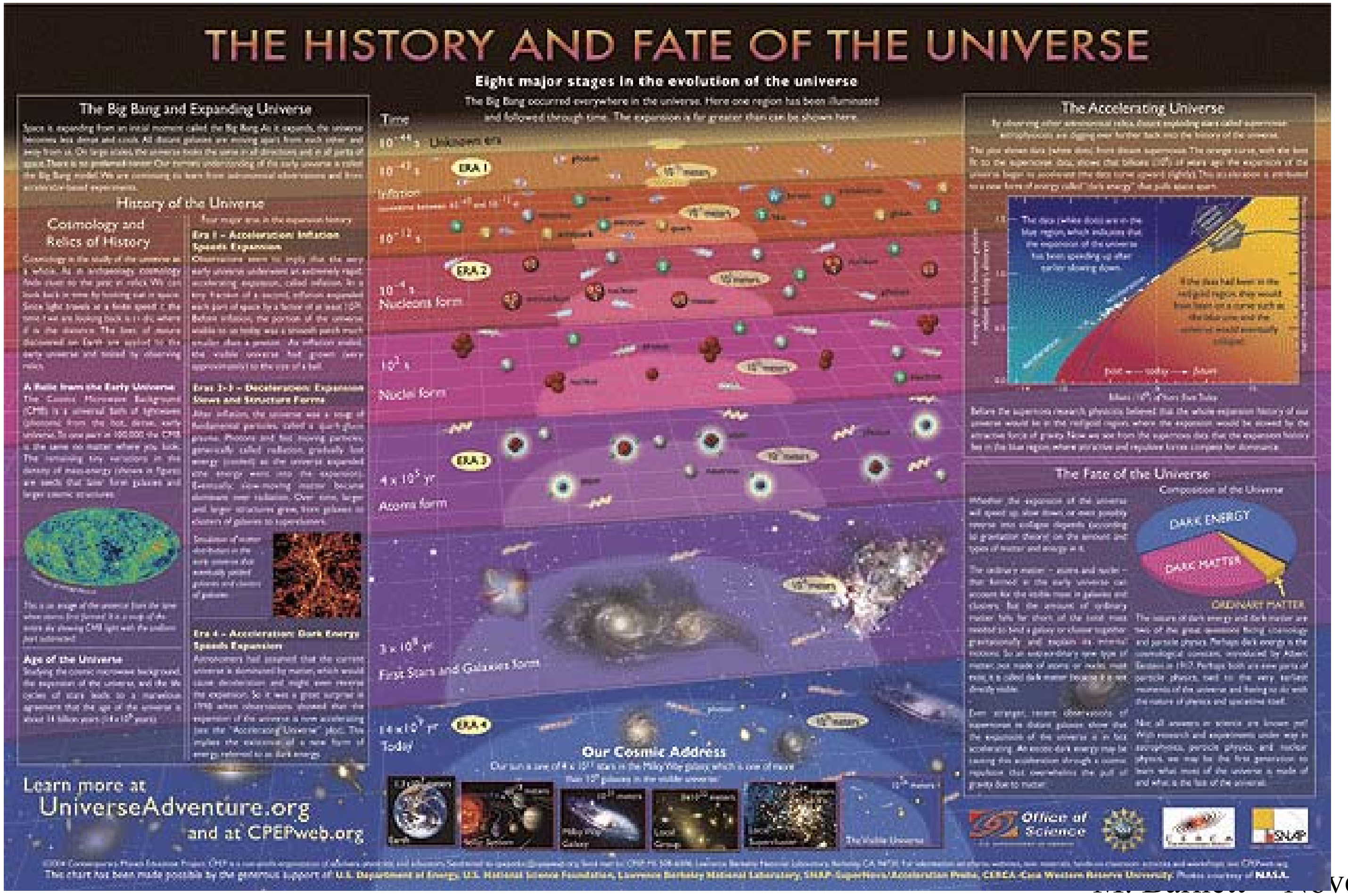
Cosmology Chart

Several years of work by physicists and teachers, and a field test in classrooms.



The History and Fate of the Universe

Chart was enclosed in the February issue of *The Physics Teacher* magazine. The AAPT magazine went to 11,000 teachers. Extensively used by DOE Office of Science Director Ray Orbach.



The Universe Adventure

UniverseAdventure.org

Under construction

How Big is the Universe?

SITE MAP GLOSSARY

The Universe Adventure

How Big is the Universe?

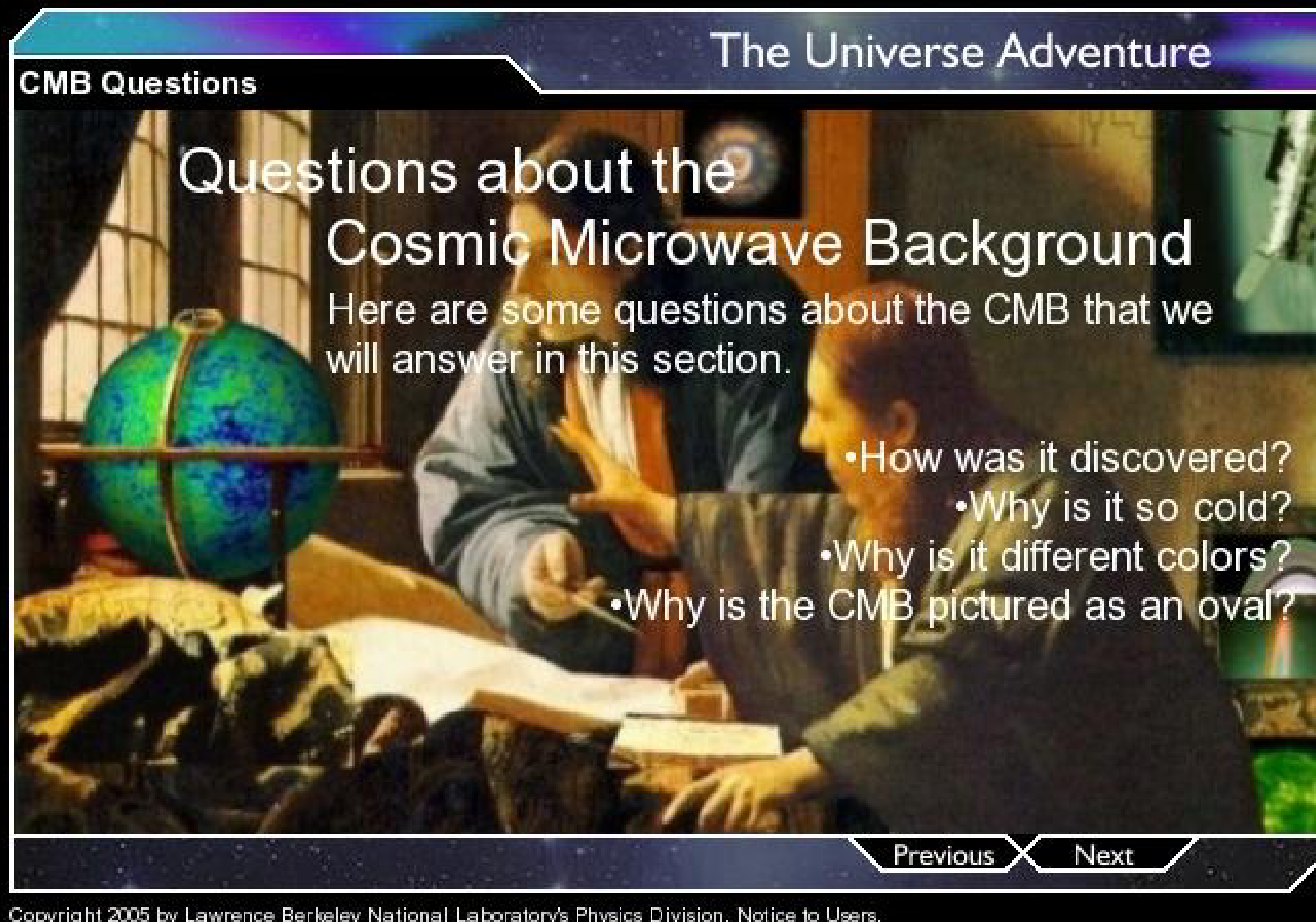
The Visible Universe

Even with the best imaginable telescopes, we can only see a small fraction of the universe. Why? Because it takes time for light to travel. So if the universe is now 14 billion years old, light can only have travelled...14 billion light years since the beginning. Thus, the part of the universe we can observe (the visible universe) lies within a sphere of radius 14 billion light years, and our earth at the center.

"The universe is THIS big."

But is the universe infinite or just big?

CMB



The Universe Adventure
CMB Questions
Questions about the
Cosmic Microwave Background
Here are some questions about the CMB that we will answer in this section.
•How was it discovered?
•Why is it so cold?
•Why is it different colors?
•Why is the CMB pictured as an oval?
Previous
Next
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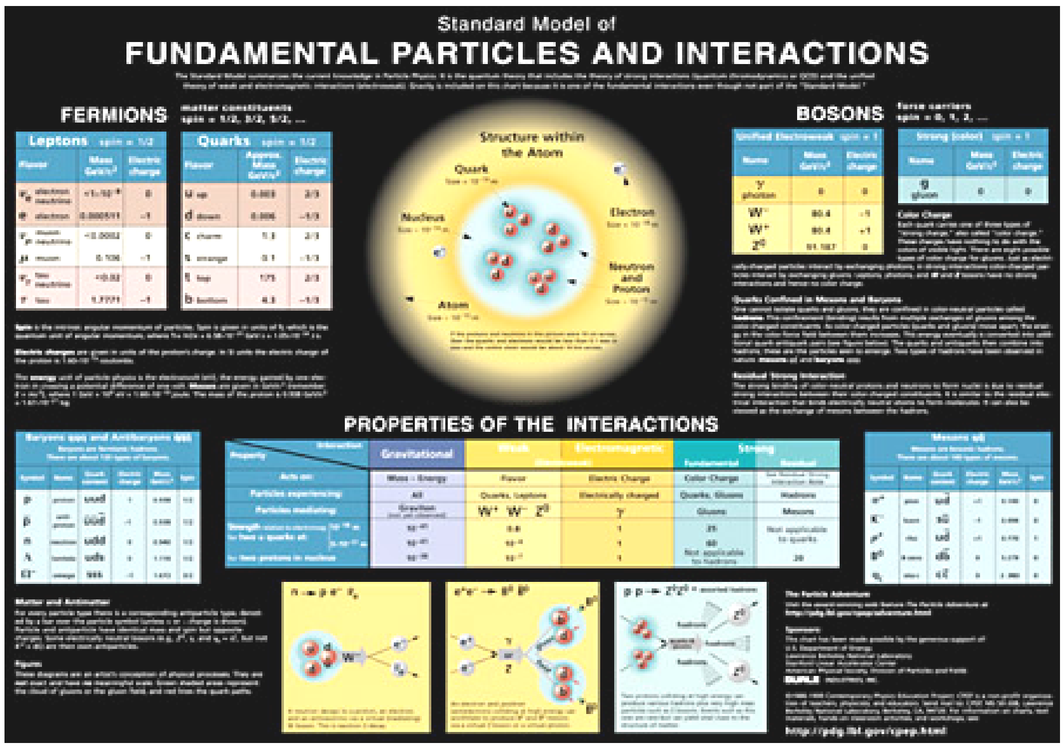
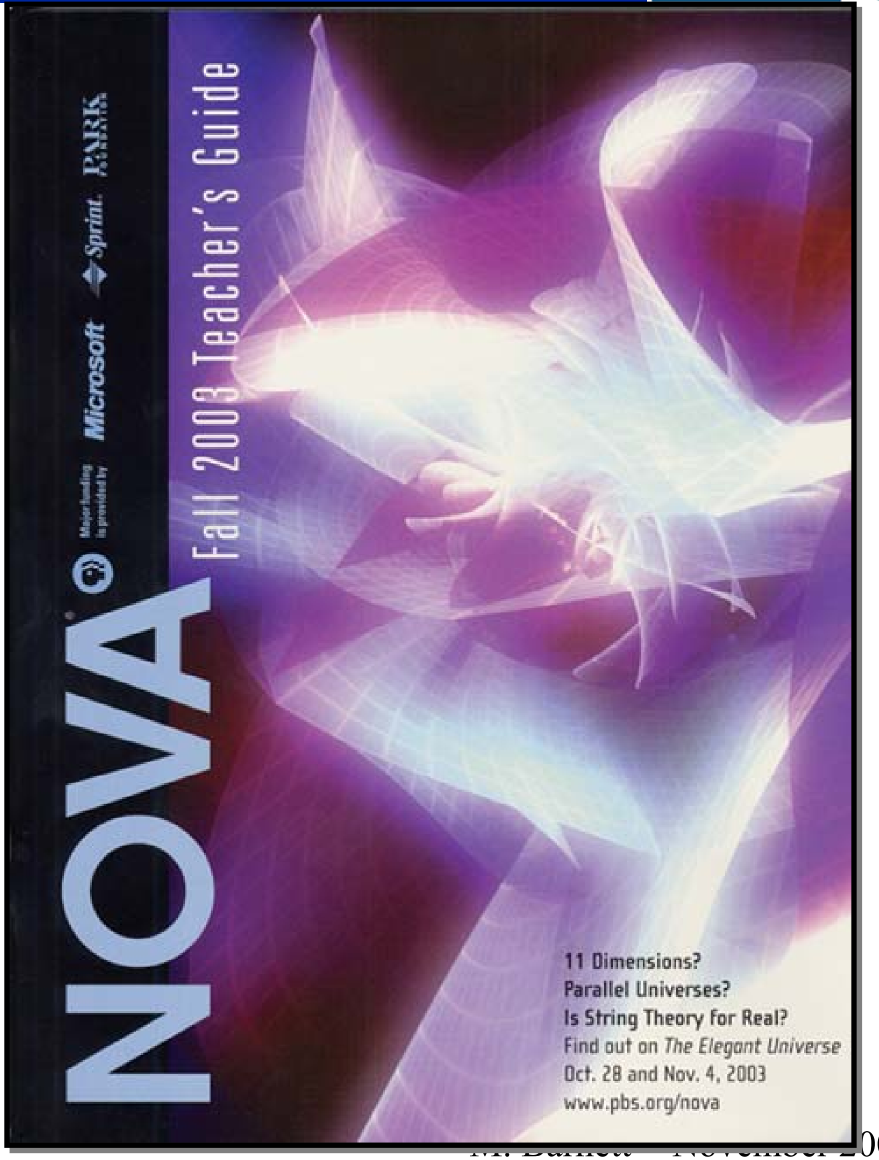
Posters Star in Movies



NOVA

Consultants for the NOVA program on string theory:

Brian Greene's Elegant Universe



Languages


see all the excitement at QuarkDance.org!
Mirror sites: USA (LBNL) | Switzerland (CERN) | UK (Durham) | Japan (KEK) | Russia (Novosibirsk) | Russia (Protvino) | Brazil | Italy (Genova)
Languages:
Chinese
(in USA / Taiwan)
Deutsch
Dutch
Español
(in USA / Spain)
Française
Greek
Italiano
Norsk
Polski
Português
Slovenska
Suomea (Finnish)
Supported by US DOE and NSF
Funding Credits
Project Credits
The Particle Data Group of Lawrence Berkeley National Laboratory presents an award-winning interactive tour of quarks, neutrinos, antimatter, extra dimensions, dark matter, accelerators and particle detectors.
The Particle Adventure
the fundamentals of matter and force
Start Here
ADDITIONAL FEATURES
Posters, CD-ROMs, and Educational Material
Book: The Charm of Strange Quarks
Particle Chart
Particle History & Summary
Glossary
Site Map, How to Use this Site
Physics Central
The Fireworks of Particles
QuarkNet Educational Program
Hands on CERN
Interesting Physics Sites
World Year of Physics 2005
We appreciate your comments.
Send email to pdgeduc@lbl.gov
Teachers may use this form
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Example of Recognition

SCIENTIFIC AMERICAN

Main Menu | Interview | Bookmarks | Feedback

Current Issue | Explore! | Ask the Experts | Marketplace | Search the Site

EXPLORE!

Physics

The Particle Adventure

If you?ve ever wondered what the heck quarks and neutrinos are, or why anyone cares, this is the site for you. Lawrence Berkeley National Laboratory?s particle physicists have created an accessible, entertaining primer on, as they describe it, what the world is made of and what holds it together. Nine sections address these fundamental questions and explore related topics, such as how researchers collect and interpret particle data, and how particles decay into other particles. One not–to–be–missed chapter covers unsolved mysteries, delving into supersymmetry, string theory, dark matter and the possible existence of extra dimensions. Other features include particle physics news and a page of links to other particle physics education sites.

Snow Crystals

A visit to this site might help you appreciate the season's flakes next time you're out shoveling them away. The author, California Institute of Technology professor Ken Libbrecht, explains everything you ever wanted to know–and then some–about natural snow, lab–made designer crystals and the physics behind them in a clear,

Discovery Channel

This site takes your students into the future. Check out this <u>totally awesome interactive site</u> for students of chemistry and physics.

A great site to introduce your students to the multimedia nature of the internet.

Wild Ride

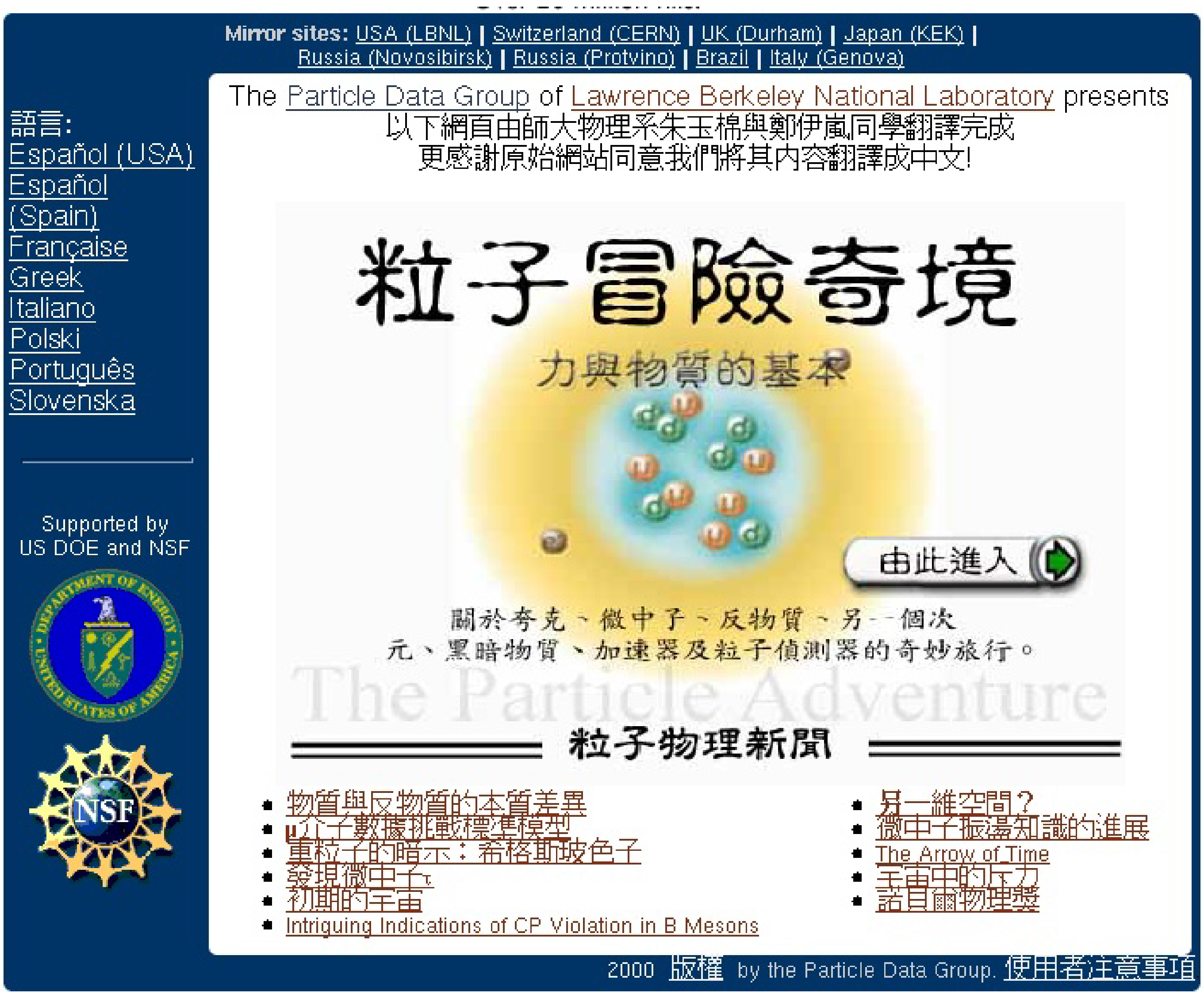
Science magazine

Wild ride. The present best theory of what all matter boils down to, known as the Standard Model, is explained in the remarkably clear and simple pages of The Particle Adventure, a widely praised site aimed at high school students.

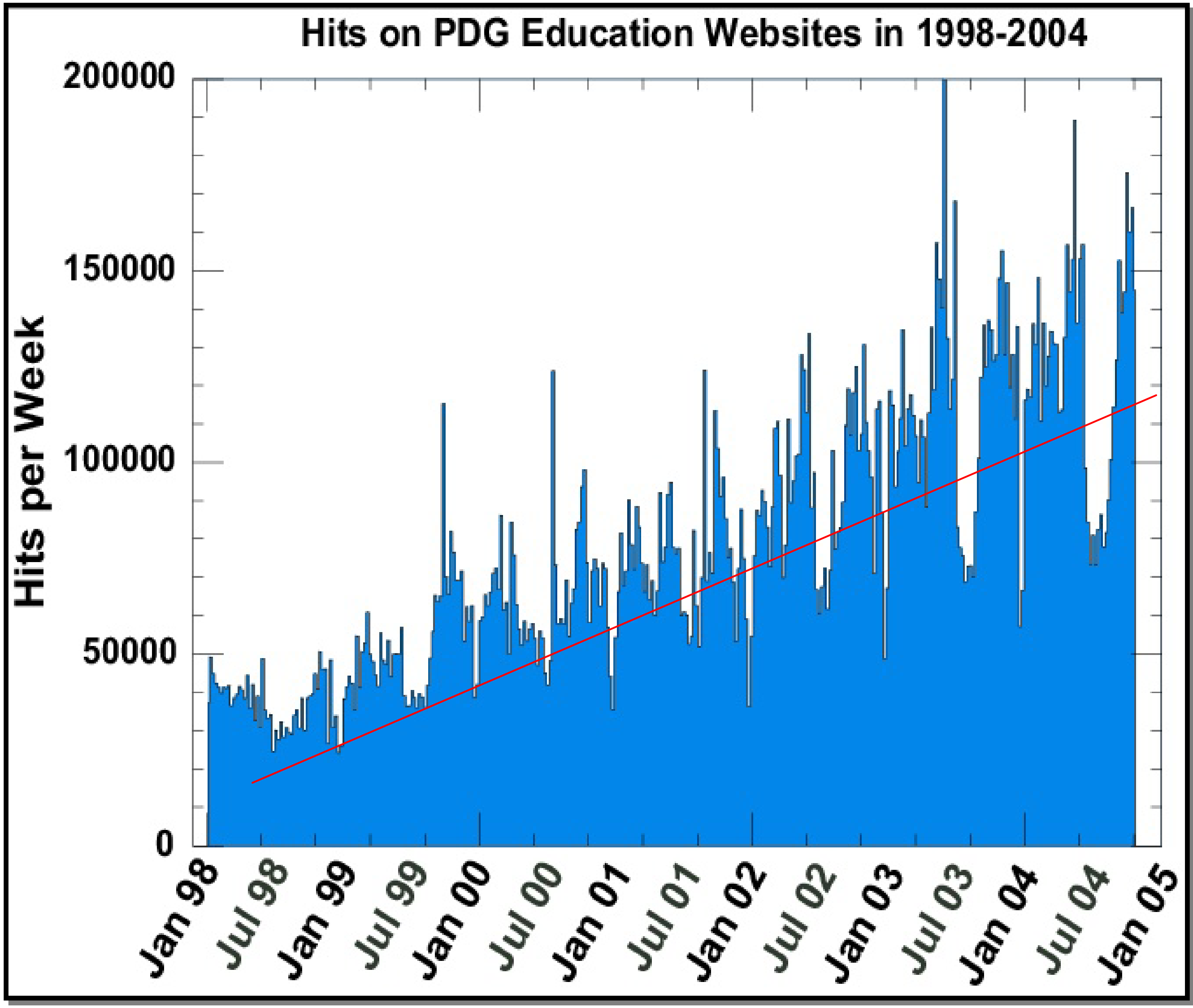
Replete with animations of decays, quizzes, and a pop-up glossary, the site starts out by discussing quarks, leptons, and other particles, lays out the experimental evidence for them, then explains the workings of giant accelerators and detectors." (June 9, 2000)

Chinese Version

Translate Text, Images, Flash & Site map (~200 pages)

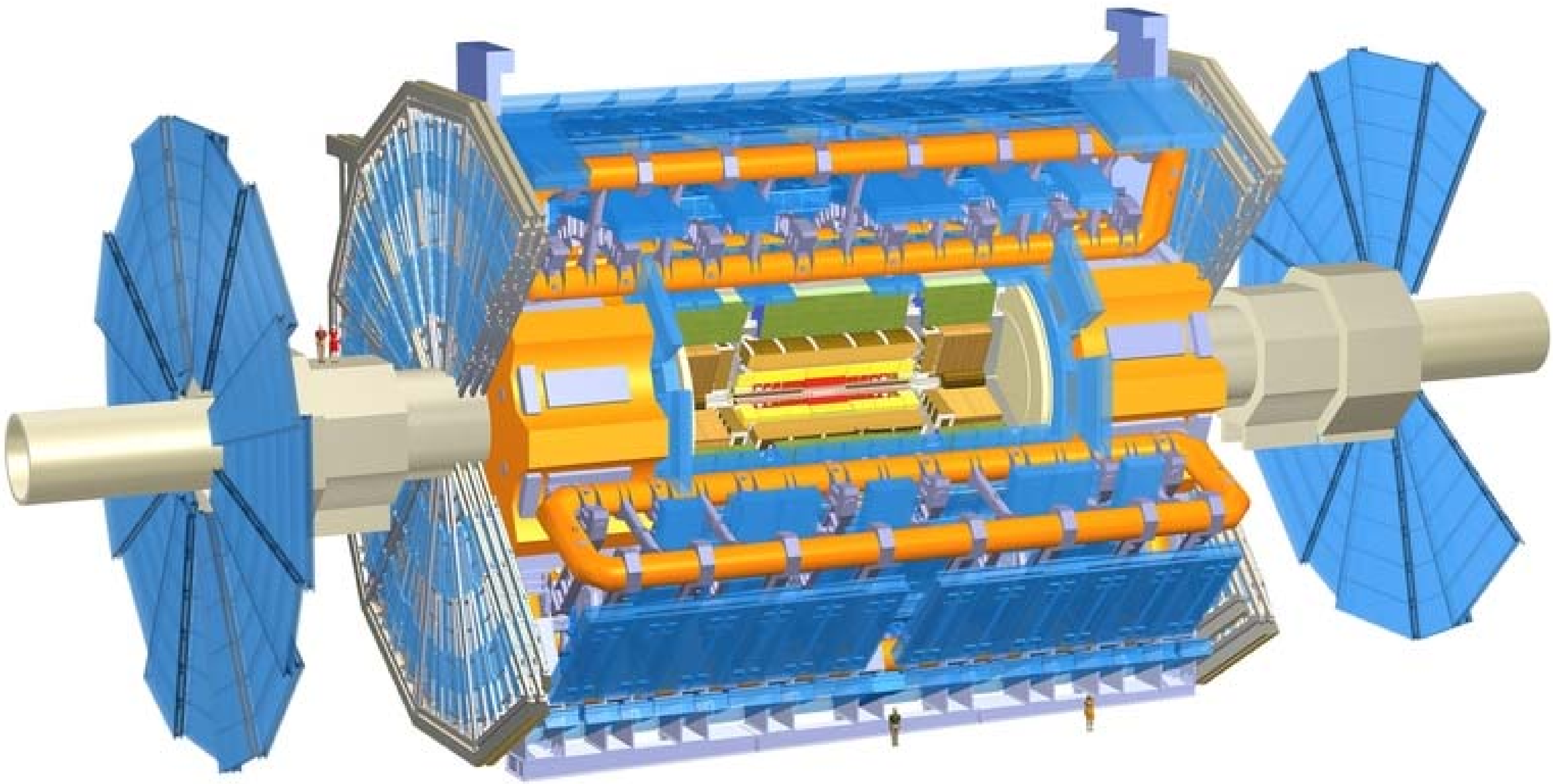


Web Usage



Hits on PDG Education Websites in 1998-2004
Hits per Week
200000
150000
100000
50000
0
Jan 98
Jul 98
Jan 99
Jul 99
Jan 00
Jul 00
Jan 01
Jul 01
Jan 02
Jul 02
Jan 03
Jul 03
Jan 04
Jul 04
Jan 05

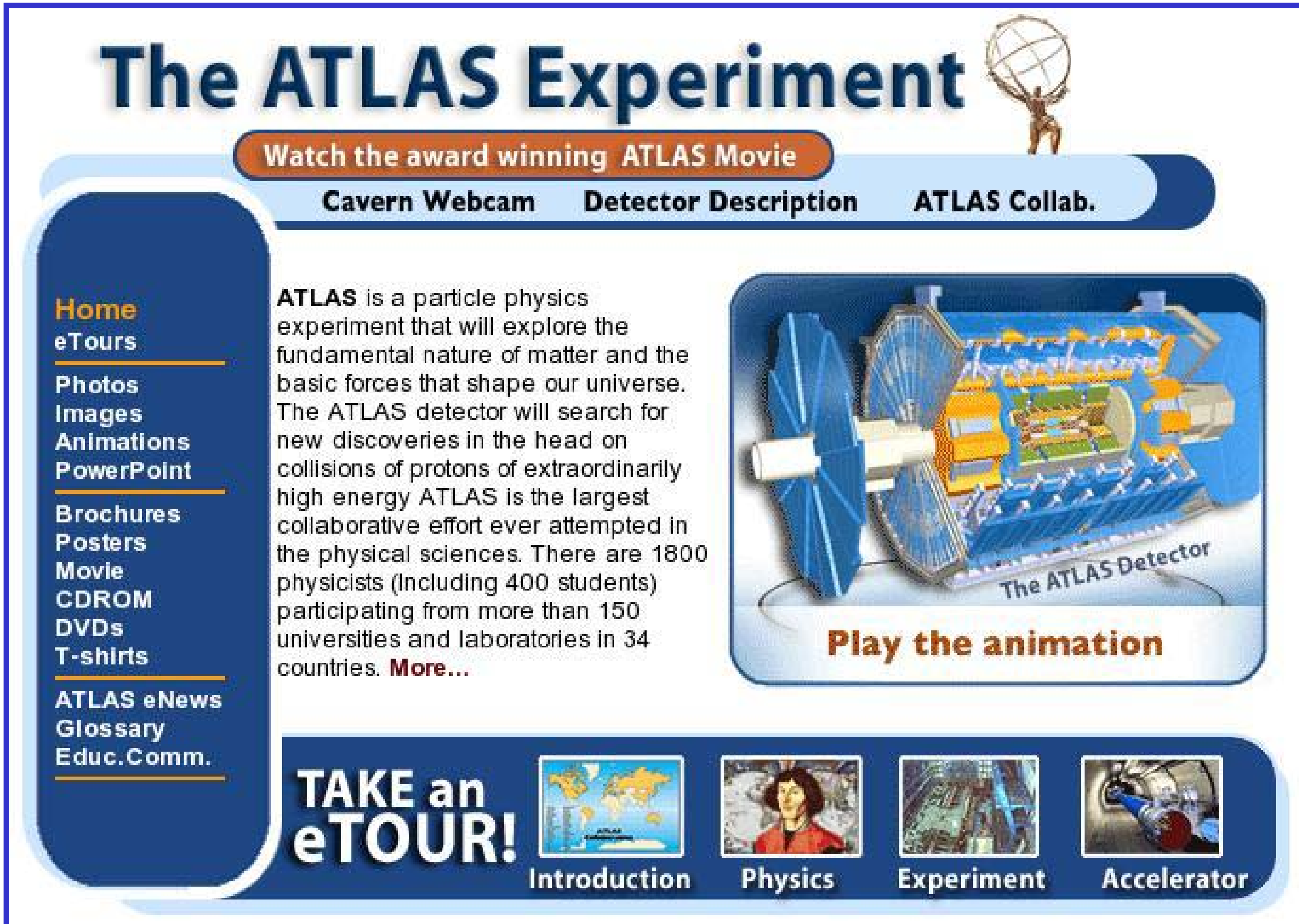
ATLAS Outreach Coordinator



M. Barnett - November 2005

http://ATLAS.ch

Public webpages with 45-second Flash animation




The
ATLAS
Movie
Collisions/sec
40000000
After first selection/sec
10000000
To memory/sec
5-10
CALORIMETER
hadron calorimeter
assembly

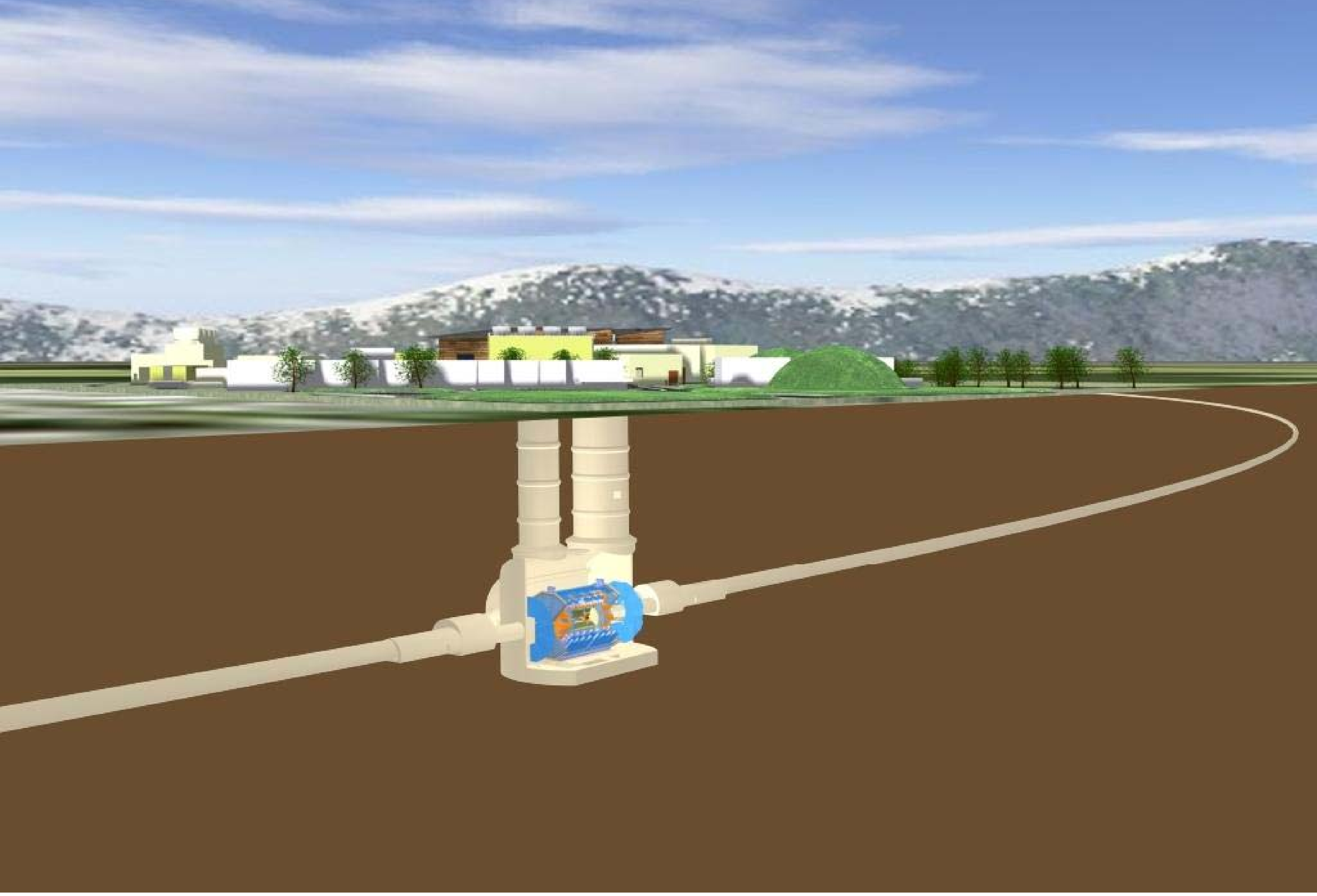
Four Gold Medals

Movie made by ATLAS Experiment's Outreach Committee has won four gold medals at int'l film festivals!

http://atlas.ch/movie

Czech, Dutch, English, French, German, Italian, Japanese, Spanish, Swedish, Chinese

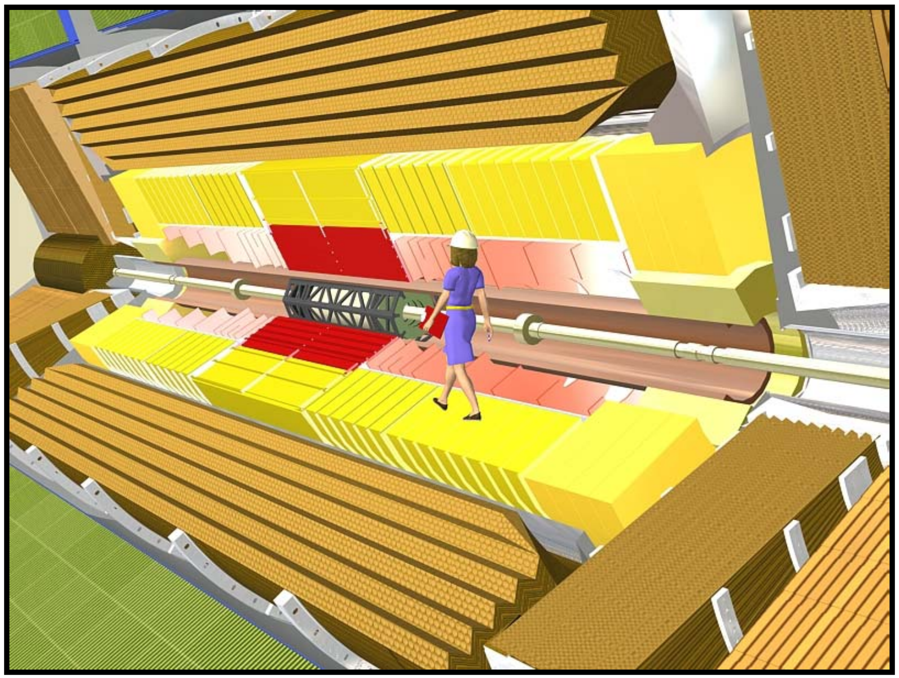
3D Animation of ATLAS

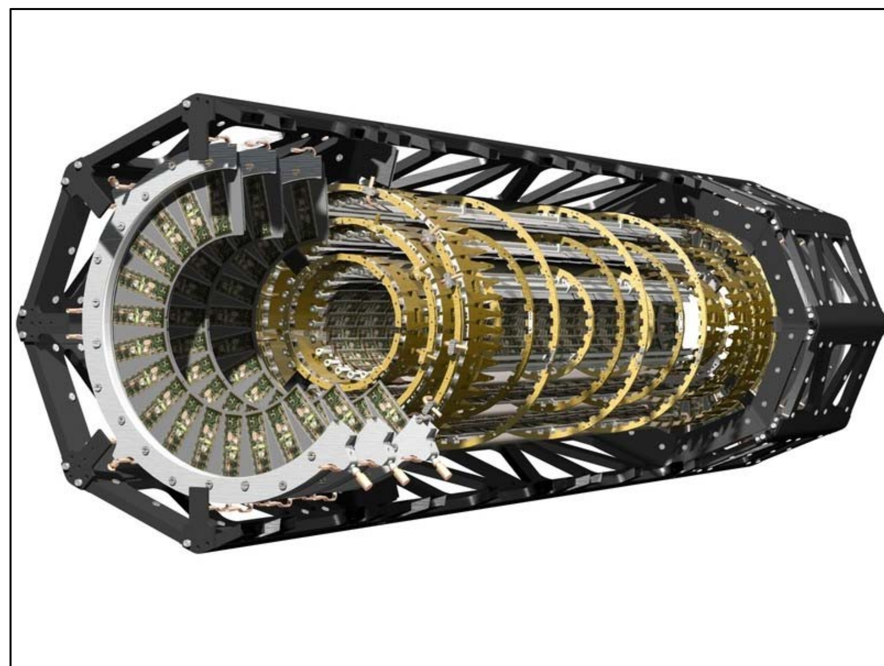


3D Animation of ATLAS

- **Construction of ATLAS**
- **Particles passing through six components of ATLAS**
- **Physics events in ATLAS**

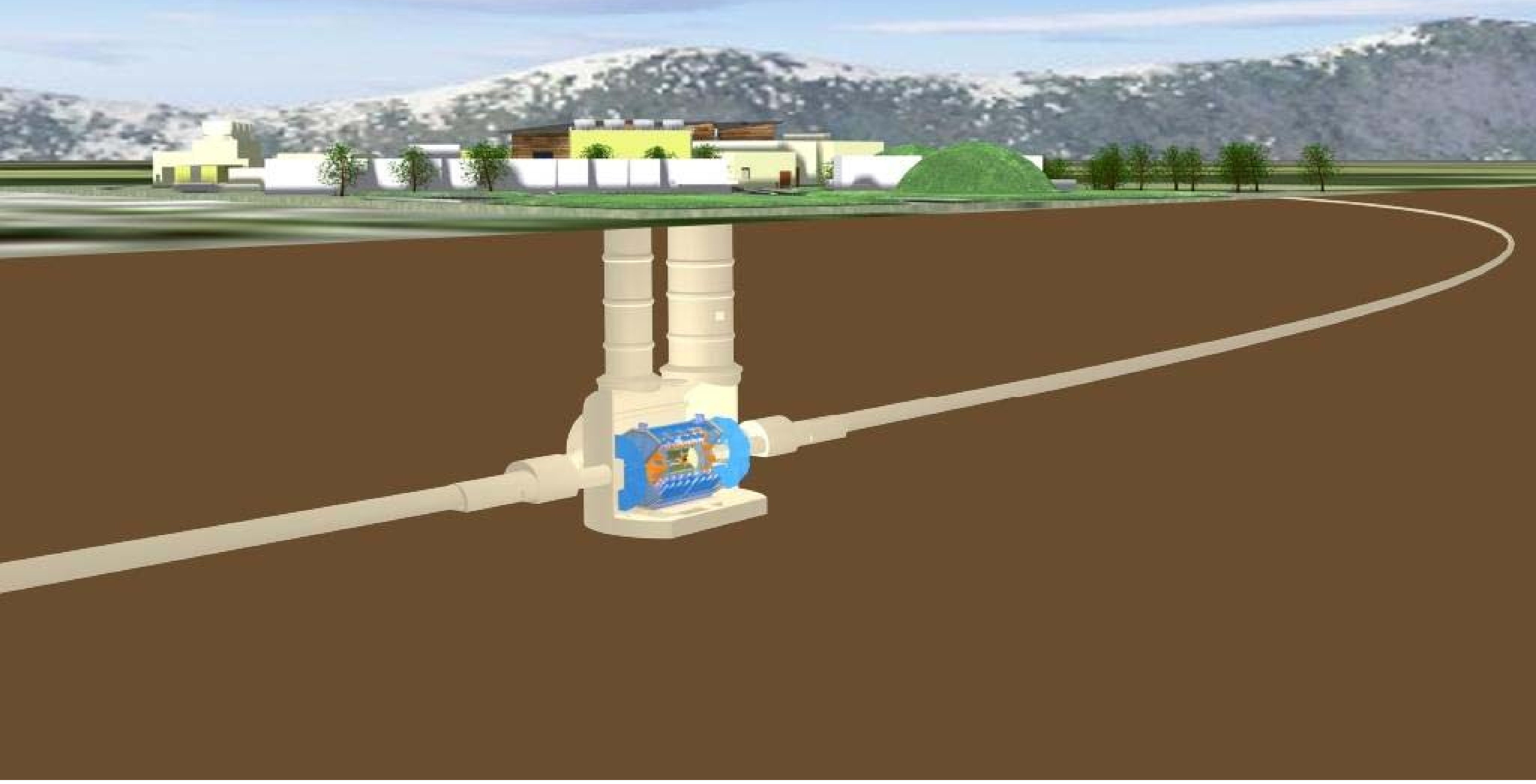
Using red-cyan glasses



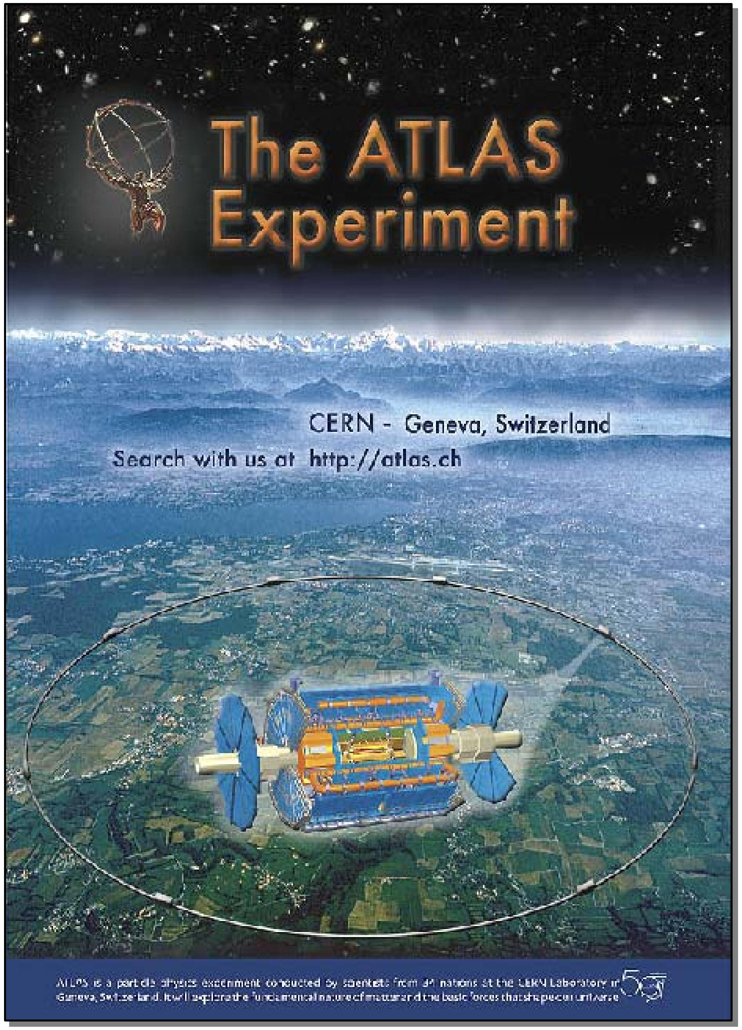


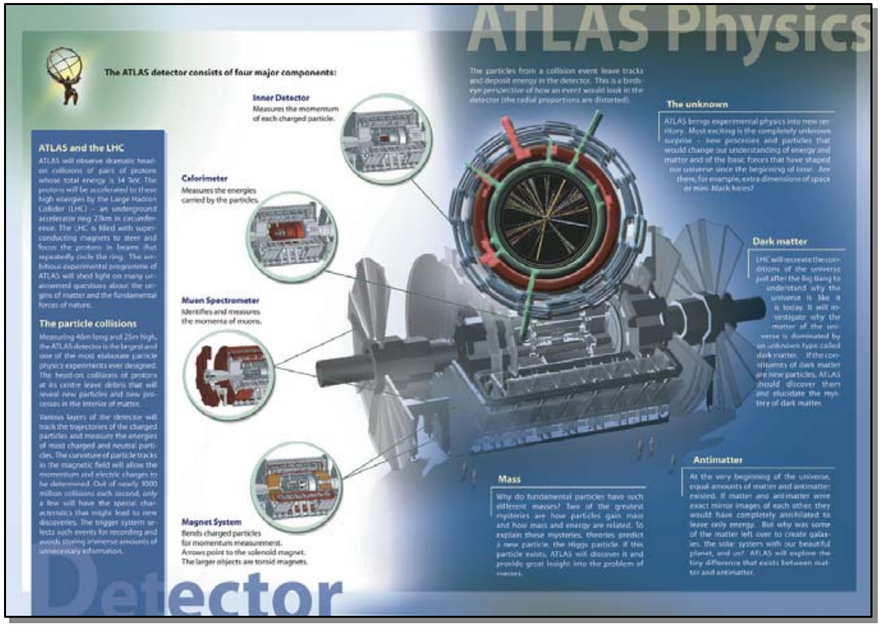
3D Animation of ATLAS

Play 3-minute segment of Episode 2 (in 2D)



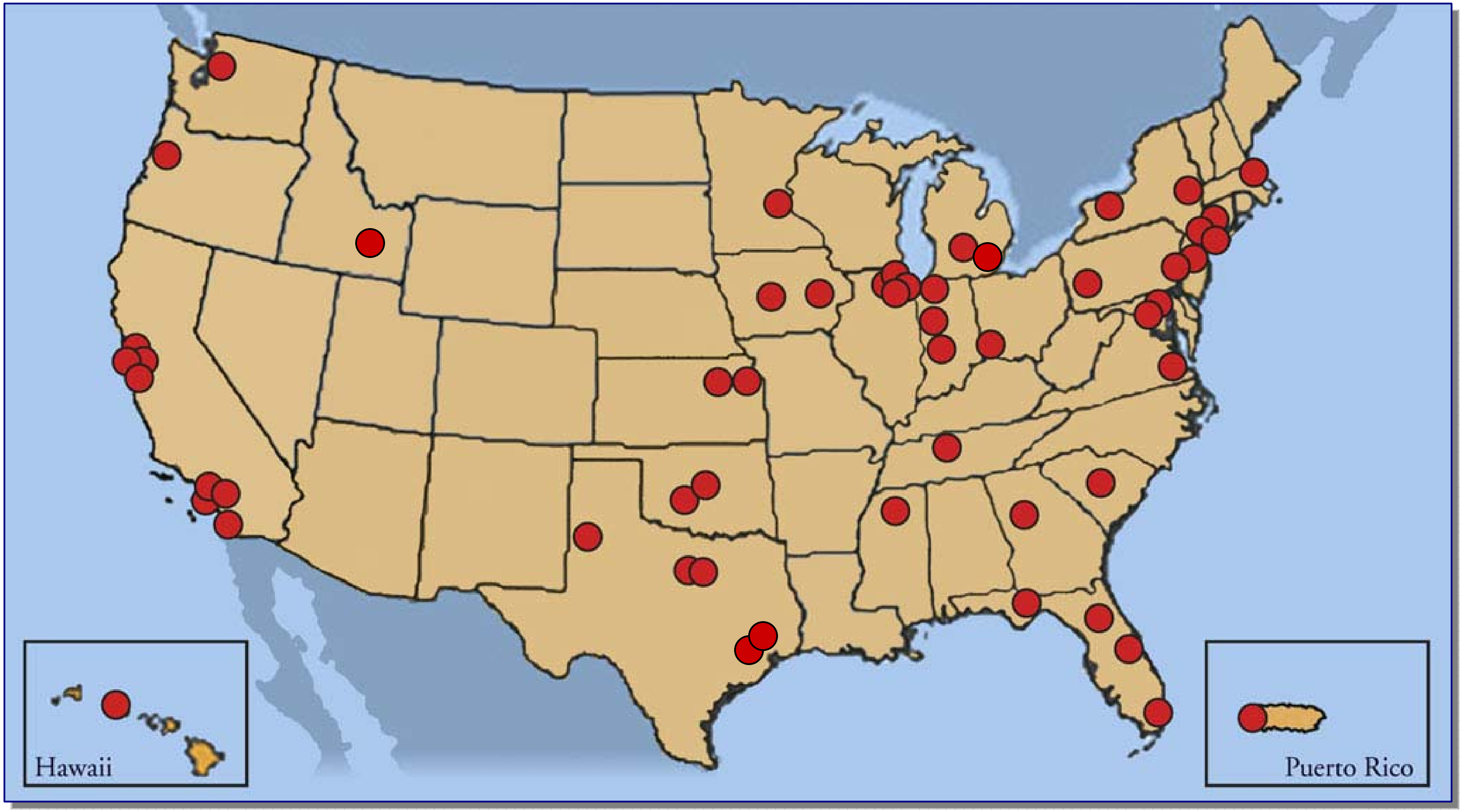
New Brochure





QuarkNet

Helping Develop America's Technological Workforce



M. Barnett - November 2005

QuarkNet CoFounder and PI

The focus of QuarkNet is to involve teachers and students in our experiments:

Teachers: do research with us and bring that excitement and experience to their classrooms;
Students: analyze web-data in their classrooms.

QuarkNet is getting students excited about science and involved in inquiry-based learning.

by getting scientists and teachers working <u>together</u>.

Nationwide Impact

Centers at 54 universities/labs.
11 different HEP experiments.
500 high schools in 37 states.
Impacts on 60,000 students/yr.

Changing teachers and teaching by making them part of research collaborations.

Our work with teachers is giving them the ability to attract and train American students.

M. Barnett - November 2005

A QuarkNet Teacher

Teacher in the "most racially diverse school system in Indiana"

“This program has enriched my teaching. I have many resources to tap into now. I have a broader knowledge base as a result of lectures and research.

“I have a warm web of friends across the United States who have the same goals as I do and who are eager to help with encouragement and advice. I feel a part of something larger and I don't feel like I am alone in the classroom any more.

“I have had several students express an interest in becoming a high school science teacher like me because what we do is so interesting.”

Another Teacher

Another QuarkNet teacher:

"I feel very strongly about the positive impact QuarkNet has made on my students, particularly since they are mostly minority, low-income kids.

"Contact with the QuarkNet program has been a terrific boost for them and started a number of students seriously thinking about going to a 4-year college and maybe pursuing careers in science."

began Summer 2001.

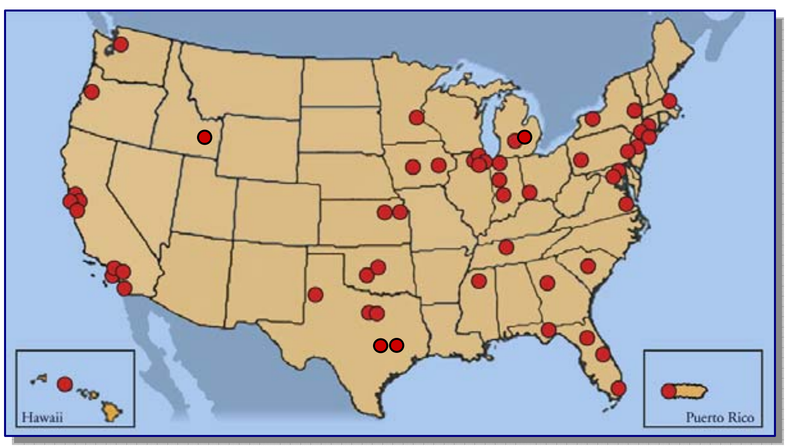
3 Lead Teachers

12 Associate Teachers.

Led by Stu Loken and Helmuth Spieler

Goodwill Ambassadors

These teachers (as well as their students and their parents) are a corps of goodwill ambassadors for particle physics.



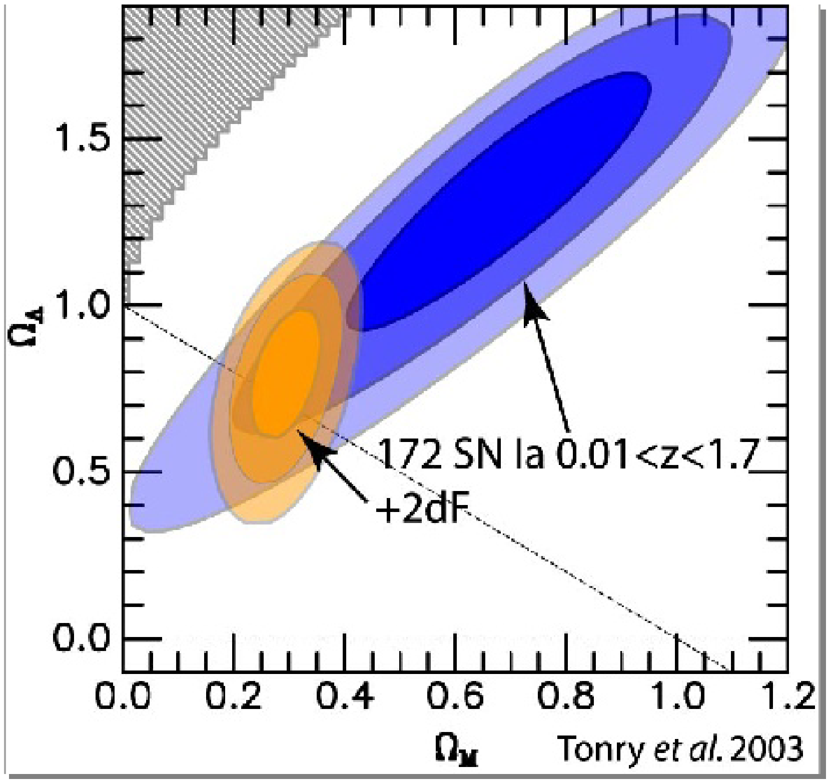
M. Barnett - November 2005

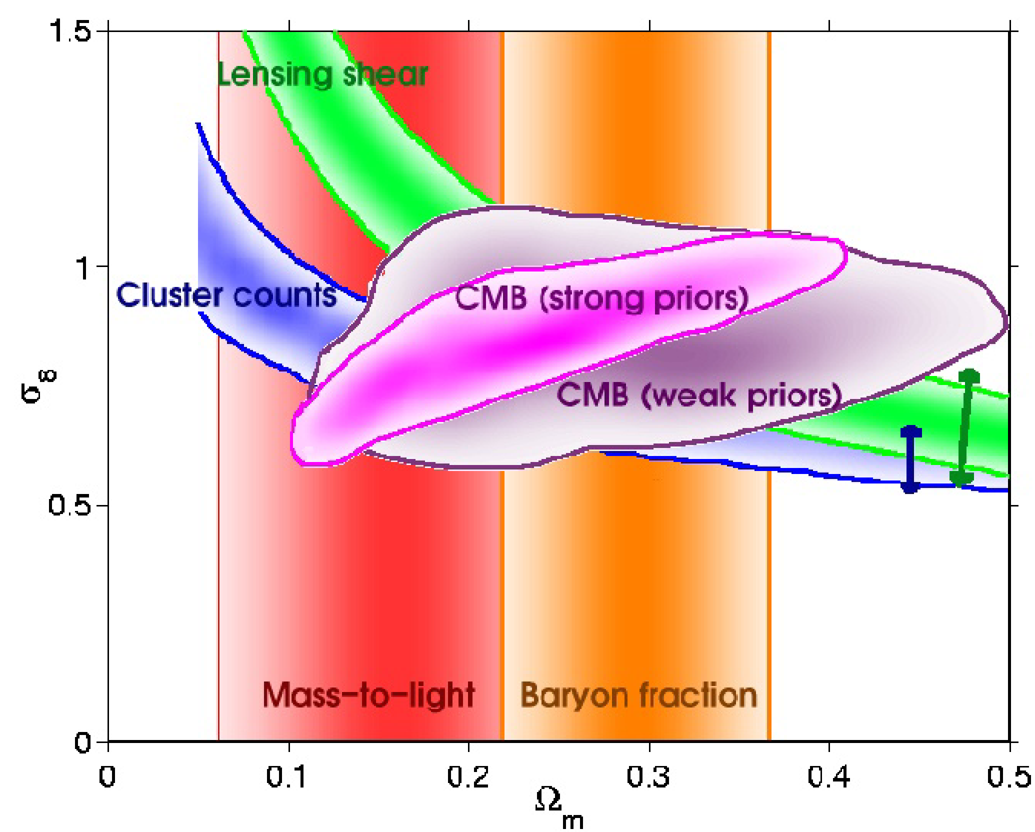
The End

The End.

Additional slides follow.

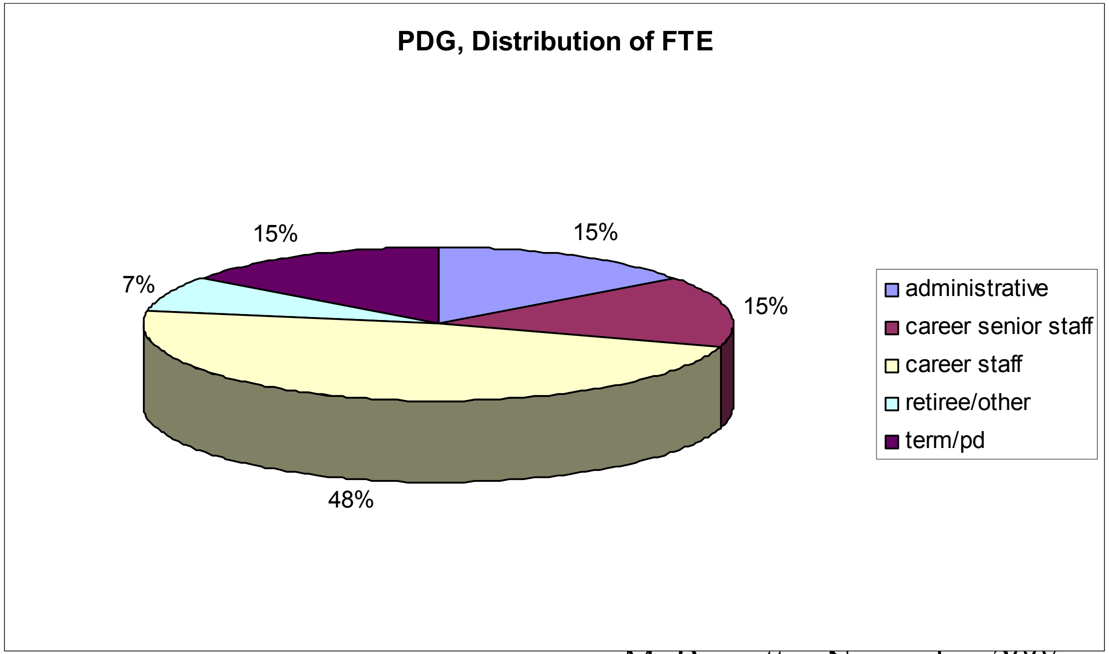
Cosmological Parameters





PDG FTE's

	FTEs
administrative	1
career senior staff	1
career staff	3.25
retiree/other	0.5
term/pd	1



Service

Service - Barnett:

Chair-Elect: APS California Section
Vice President: N. California AAPT
Co-founder: Contemporary Physics Education Project
Co-founder/PI: QuarkNet
Coordinator: ATLAS Education and Outreach Committee

The original 1957 table

Table I

Masses and mean lives of elementary particles; November, 1957
(The antiparticles are assumed to have the same spins, masses, and mean lives as the particles listed)

	Particle	Spin	Mass (Errors represent standard deviation) (Mev)		Mass difference (Mev)		Mean life (sec)		Decay rate (number per second)
Photon	γ	1	0				stable		0
Leptons	ν	$\frac{1}{2}$	0				stable		0
	e^-	$\frac{1}{2}$	0.510976	(a)			stable		0
	μ^-	$\frac{1}{2}$	105.70 $\pm$0.06	(a)			$(2.22 \pm 0.02) \times 10^{-6}$		0.45×10^{6}
Mesons	π^+	0	139.63 $\pm$0.06	(a)	4.6 (a)		$(2.56 \pm 0.05) \times 10^{-8}$	(a)	0.39×10^{8}
	π^0	0	135.04 $\pm$0.16	(a)			$< 4 \times 10^{-16}$	(d)	$> 2.5 \times 10^{15}$
	K^+	0	494.0 $\pm$0.2	(g)	0.4 $\pm$ 1.8		$(1.224 \pm 0.013) \times 10^{-8}$	(h)	0.815×10^{8}
	K^0	0	494.4 $\pm$1.8	(i)		K_1:	$(0.95 \pm 0.08) \times 10^{-10}$	(e)	1.05×10^{10}
						K_2:	$(4 < \tau < 13) \times 10^{-8}$	(c)	$(0.07 < \tau < 0.25) \times 10^{8}$
Baryons	p	$\frac{1}{2}$	938.213 $\pm$ 0.01	(a)			stable		0.0
	n	$\frac{1}{2}$	939.506 $\pm$ 0.01	(a)			$(1.04 \pm 0.13) \times 10^{+3}$	(a)	0.96×10^{-3}
	Λ	$\frac{1}{2}$	1115.2 $\pm$0.14	(j)			$(2.77 \pm 0.15) \times 10^{-10}$	(k)	0.36×10^{10}
	Σ^+	$\frac{1}{2}$	1189.4 $\pm$0.25	(l)	7.1 $\pm$ 0.4		$(0.83\ ^{+.06}_{-.05}) \times 10^{-10}$	(m)	1.21×10^{10}
	Σ^-	$\frac{1}{2}$	1196.5 $\pm$0.5	(n)	$6.0^{+1.4}_{-0.9}$		$(1.67 \pm 0.17) \times 10^{-10}$	(o)	0.60×10^{10}
	Σ^0	$\frac{1}{2}$	$1190.5^{+0.9}_{-1.4}$	(p)			$(< 0.1) \times 10^{-10}$ theoretically $\sim 10^{-19}$	(b)	$> 10 \times 10^{10}$ theoretically $\sim 10^{19}$
	Ξ^-	?	1320.4 $\pm$ 2.2	(q)			$(4.6 < \tau < 200) \times 10^{-10}$	(f)	$(> 0.005, < 0.2) \times 10^{10}$
	Ξ^0	?	?				?		

M. Barnett - November 2005

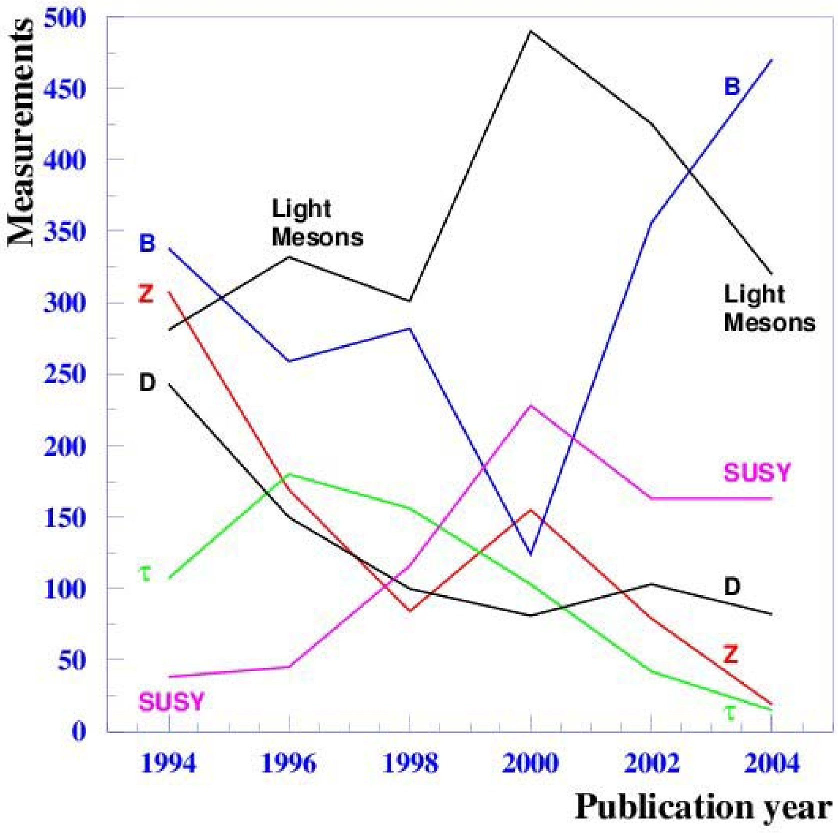
LBNL Director's Review

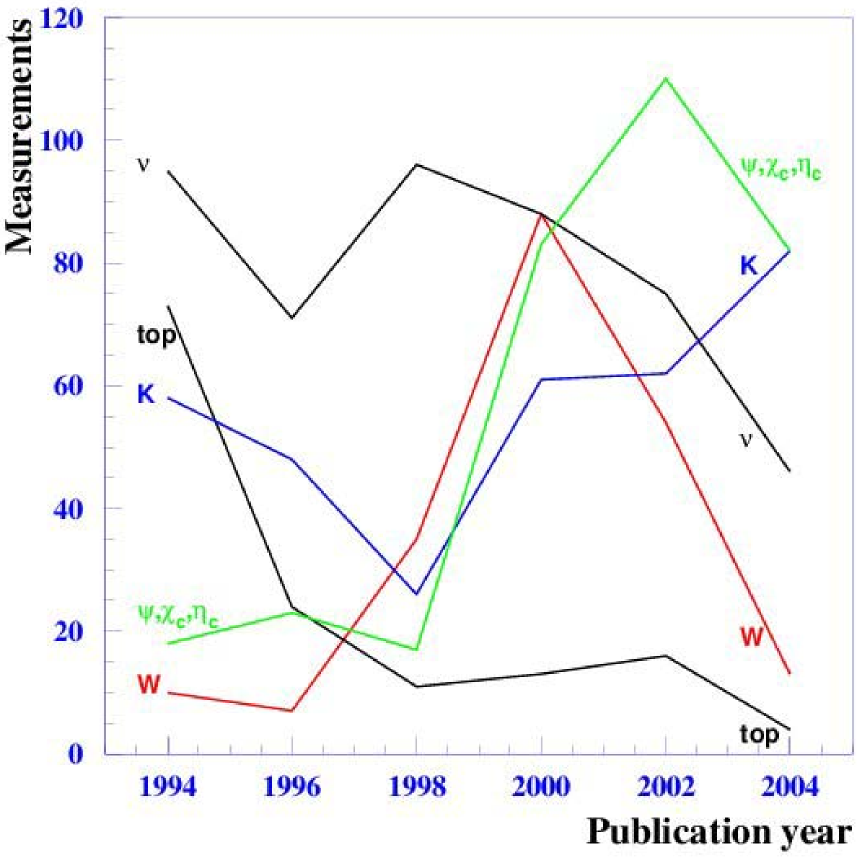
"In education and outreach, LBNL is very active on several collaborative educational projects, including the Quarknet program for high school teachers; the Contemporary Physics Education Project, which develops posters and teaching materials for high schools; the award-winning Particle Adventure website; and the new Universe Adventure website now being developed.

Michael Barnett, head of PDG at LBNL and a leader in education and outreach at LBNL, is also the ATLAS Outreach Coordinator."

November 2004

Trends in coverage





M. Barnett - November 2005